VOL. 17, NO. 2 • FEBRUARY 1961

SPE JOURNAL

The Official Publication of the Society of Plastics Engineers, Inc.

EDITORIAL DEPT.
UNIVERSITY MICROFILMS, INC.
313 N. FIRST ST.
ANN ARBOR, MICH.

new instrument speeds PLASTISOL FORMULATION

- page 174

President Reynolds sets SPE GOALS for 1961

- page 183

guide for smooth operation of high density POLYOLEFIN SHEET EXTRUSION

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End

Problems of Environmental

Stress Crack

in housewares, containers, spouts and closures of molded polyethylene, with new

Spencer "Poly-Eth" 4200 Resins

Will your product fail your customers because environmental stress cracks develop and cut short its useful life? Resins are now available which eliminate or minimize this chronic problem. Why risk it? Read how new Spencer "Poly-Eth" 4200 series resins can greatly increase your product's resistance to this type of cracking:

If you deal in items of molded polyethylene, you are aware of environmental stress cracking. While this problem is not serious in all molded polyethylene products, those that come in contact with certain reagents such as soaps and detergents are subject to this type of cracking.

For instance, when detergents cause a bottle pouring spout or dishpan to crack, environmental stress cracking may be the problem. Now, at no extra expense, you can overcome this major cause of cracking!

Upgrade your polyethylene product by molding it of new Spencer "Poly-Eth" 4200 resin—the advanced new polyethylene molding resins that laugh off environmental stress cracking. It costs no more to put this important extra durability into your molded product. Just specify a new Spencer "Poly-Eth" 4200 series resin!

Free technical assistance is available to help you discover how these amazing new Spencer "Poly-Eth" 4200 resins can improve your molded product. Without obligation, our technical representative will be happy to work with polyethylene molders. Write now at the address below for further information.

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Specimen made of next best competitive polyethylene resin failed after 123 minutes of testing.
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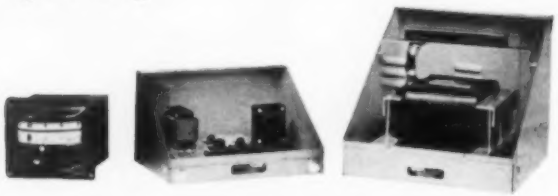

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The most compact programming system available includes Model JSBG (left) for any operation involving a time-temperature cycle. Its simply cut cams integrate and control time with temperature.

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SPE JOURNAL
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FEBRUARY 1961

COVER: Photograph shows equipment train used by Phillips Chemical Co. to develop data on how to equip, start-up, and trouble shoot common operating difficulties of sheet extruder.

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U.S.I. POLYETHYLENE NEWS

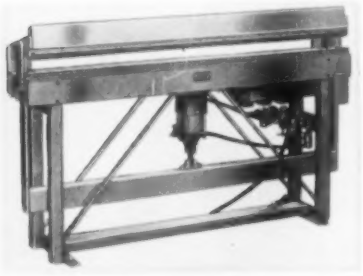
A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

Packaging Notes

High-speed bottle blowing machine available from a Danish firm produces 5,000 finished bottles per hour, according to a recent announcement. Fully automatic, it operates with 1 to 5 molds, can work on 11 different cycles, has 3 interchangeable tables (up to ½, 2½ and 5 gallons).

Squeezable ink bottle blow-molded of conventional polyethylene permits tidier filling of fountain pens. Pressing the sides of the bottle draws ink into a special well from which pen is easily filled.

Extra-length heat sealer designed for use with thin polyethylene films makes seals up to 96" long. The latest of a series of heavy-duty, all-steel thermal units available from a New York company, it operates by foot switch and has a pneumatic safety system. Can be adapted with built-in "recycler" for automatic operation and completely controlled integral compressed air supply.



Polyethylene filling cover for drums and tanks has cavity to catch dangerous and costly spillage. It has built-in handles, expandable fill pipe opening and molded pouring lip. And, according to the producer, is chemical resistant, lightweight and unbreakable.

New moisture-tight bags, designed for highly hygroscopic products, are constructed of strong white paper laminated to aluminum foil with polyethylene coating on the foil side. All seams are heat-sealed, as is the top after filling.

A California company chose these bags over cans of comparable capacity for its instant apple sauce. Extensive testing showed they resist moisture and retain vitamins; cost 48% less than cans, take 23% less space and weigh 10% less. The product is being packaged semi-automatically in 19 oz. and 7-lb. bags flexographically-printed in red, green and yellow.

Polyethylene Mulch Film Permits Early Crop Set and Harvest . . . Ups Marketable Yields

Increases Test Yields of Vegetables As Much As 100%

Recent tests at the Oregon State College Agricultural Experiment Station, Corvallis, and the South Dakota State College Agricultural Experiment Station, Brookings, have proved that polyethylene mulch film more than justifies its cost.

See the difference polyethylene mulch film can make? The plant at left was grown with film, the one at right without. Note healthier look, greater yield.

Findings were cited by James P. Menn, staff agronomist of the U.S. Industrial Chemicals Co., at the 73rd Annual Meeting of the Florida Horticultural Society.

Mr. Menn noted that the Oregon State College tests on tomatoes resulted in a marketable yield of over 20 tons per acre with polyethylene mulch, 10 tons per acre without. Marketable pole bean and cantaloupe yields also were considerably greater when the mulch was used. At South Dakota State College, too, significant yield increases were reported for sweet corn, snap beans, carrots, cabbage, and cucumbers.

Available commercially in durable, flexible, lightweight black film, polyethylene mulch provides special protection because of its high impermeability to water vapor and gases. Its physical properties can be varied to raise or lower soil temperatures, conserve soil moisture and control weeds and plant diseases. Consequently, it often results in early crop set and harvest as well as increased marketable yields.

The U.S.I. agronomist pointed out that some 33 land grant colleges are now carrying on, or have recently completed, research projects on polyethylene and other plastic mulch materials.

New Connector For Polyethylene Tubing

A new kind of fitting, claimed to connect small-diameter polyethylene tubing simply and economically in just two seconds, has been introduced. According to the manufacturer, the new connector will open up possibilities of replacing metal tubing with lower-cost polyethylene tubing in electrical appliances, automotive equipment and other industrial applications.

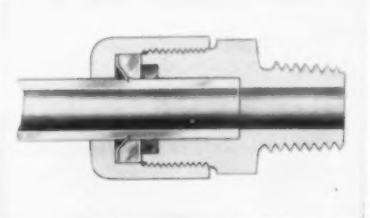


Photo courtesy D & G Plastics Co.

The fitting is an O.D. type, so there is no restriction to flow. Connection is made by merely inserting tube into the fitting with a twisting motion as far as it will go. Result is a positive seal—leakproof for vacuum, gases and fluids over a wide range of temperatures and pressures.

Connectors are guaranteed by the manufacturer to meet all requirements governing the transmission of fluids for human consumption. Available for use with standard tubing ¼", ⅜", ½" and ⅝"—either male or female threads.

Oil-Resistant Ink System For Polyethylene Film

Shredded coconut and other products high in vegetable oils can now be packaged in polyethylene film printed in as many as five colors. A new oil-resistant ink system, sold at no extra charge over regular ink systems, has been successfully tested on thousands of bags, its developer reports.

Previous ink formulations used on such oily products would soften or rub-off on nearby packages or customers' hands. Destructive tests on the new inks have shown no deterioration and have proved out shelf life and oil resistance. Special printing plates used are compatible with the inks.

DO YOU HAVE a new polyethylene product or development you'd like the industry to know about? Make it routine to send your information on new developments to **U.S.I. POLYETHYLENE NEWS.**

Address:

U.S.I. POLYETHYLENE NEWS, U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corp., 99 Park Avenue, New York 16, N. Y.

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Member of the Audit Bureau of Circulations

The Processing of Plastics — More Complex than Ever

While attending a recent ACS Section meeting, this conversation was overheard: "We Know MWD (molecular weight distribution) has a considerable influence on polymer properties, but we don't know exactly how much. Our company is spending a lot of money to get the complete story." Or switch the scene to a successful blow molding company, where the president of that company has just finished a discourse on the high fatality rate among blow molding companies: "Before you go into blow molding, you have to know something about polymer properties, melt index, and stress relaxation."

What these people are saying is that the processing of plastics is no longer a simple job. There are just too many resins tailored for specific applications and processes. Without a knowledge of the behavior of the material during processing, the molder will be working completely in the dark.

What can the processor do about it? There are several steps, it seems, which could help if they were followed:

1. Ask questions of the technical sales and service representatives who call on you. They are the most important means of linking you with the latest information on processing developed in their laboratory. Visit a materials supplier technical service laboratory. Then you can see first hand possible solution to problems which you may have.

2. Read appropriate sections of those volumes of the SPE Plastics Engineering Series. For instance, Volume II, Processing of Thermoplastics contains excellent discussions of theory and practice of all the major thermoplastics processing techniques.

3. **Study,** not just read, articles in journals covering the latest technical information relating to plastics processing.

4. Go to SPE meetings. There, at both the local and international level, you will experience an interchange of ideas and technology that will keep you abreast of the latest happenings in the industry.

5. **Practice** what you **learn.**

IMPCO'S NEW SECOND-STAGE INJECTOR

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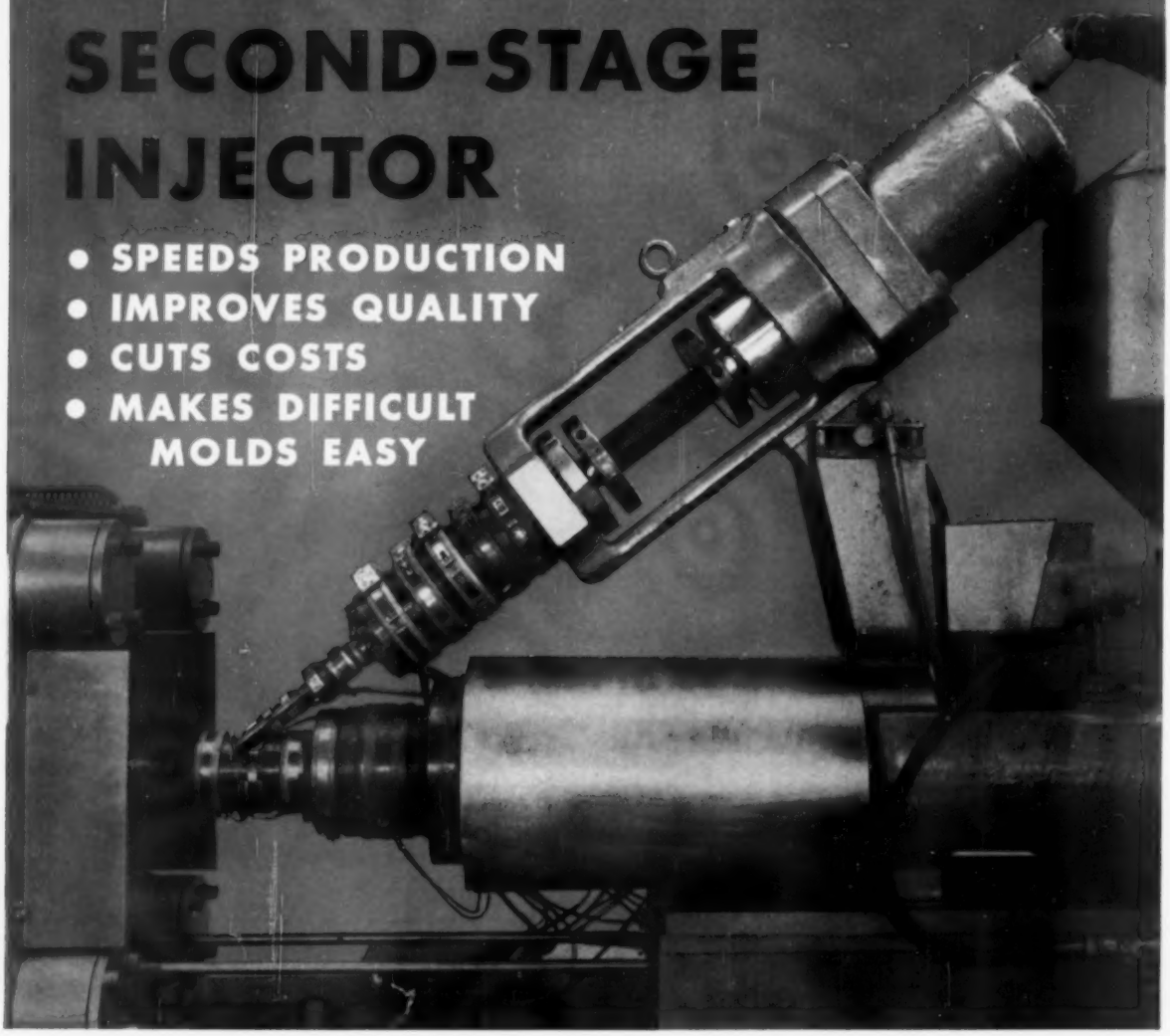

The Second Stage Injector was designed to increase the effective operation of any Impco Injection Molding Machine now in service. It is also now available as standard equipment on new Impco machines. Its use gives you:

- Raw material savings
- Increased capacity
- Reduced molding pressures
- Increased mold area
- Simplified nylon molding
- Fewer rejects

Ask for Bulletin P-127 for more information.

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Letters

Young Scientist

Dear Sir:

I am in the 7th grade and working on a science project of plastics. I would appreciate it very much if you would please send me some pamphlets on plastics.

Nancy Bishop
Wilmington, Ohio

Editor's Note

Many similar letters come into the SPE Journal each month, and every effort is made to supply the information requested.

Test Methods for Vinyls

Dear Sir:

We would like to ask Mr. J. B. DeCoste a question regarding his paper Advances in Vinyl Plastics Test Methods appearing in the October issue of the SPE Journal.

He makes reference to an ASTM test for fungi and bacterial attack on plastics.

Could we be advised how far this work has progressed, is there an ASTM test specification, and is the test now recognized by SPE?

R. H. Greene
Canadian General Electric Co., Ltd.
Montreal, Que.

Author's Reply

The fungal portion of the method is now in its final stages of preparation. It is currently out to Committee D-20 letter ballot for approval and if events follow their expected course it might have Society acceptance by early spring.

The bacterial portion of the method has been temporarily withdrawn. The problem of finding a suitable bacterium that will be non-hazardous to personnel has not as yet been solved. Sub-committee V is investigating organisms for this purpose but it will probably be some time before they have an answer.

J. B. De Coste
Bell Telephone Laboratories
Murray Hill, New Jersey

Too Abstract

Dear Sir:

I have been very unhappy with the type of article in the SPE Journal and I think it has gotten far too theoretical and abstract and that once in awhile you need a general interest article.

A. R. Morse, President
Injection Molders Supply Co.
Cleveland

TENITE DEVELOPMENT LABORATORY
DOINGS AND FINDINGS

POLYPROPYLENE PRIMER

Stereoregular . . . stereoblock . . . amorphous . . . smectic . . . Hectic?

Stereoregular polypropylene, with neatly spiraling polymer chains, is basically what you get in commercial polypropylene plastic. The molecules can spiral either clockwise or counterclockwise (*d* or *l* configurations), but to the best of our knowledge one configuration is as good as the other. What *is* important is that the molecular corkscrews be regular so that one can snuggle closely to another. This arrangement results in high crystallinity and gives the plastic great stiffness and hardness.

Under certain conditions, *stereoregular* molecules may pass through what appears to be a state of low-order crystallinity sometimes referred to as **smectic.** It is a highly unstable state, easily eliminated by a little heat. Although fascinating to the polymer chemist, *smectic* polypropylene means little to the processor.

Commercial production of stereoregular polypropylene also produces minimal amounts of *amorphous* and *stereoblock* polypropylene. **Amorphous** molecules — unlike stereoregular — twist and turn erratically, making tight packing (good crystal formation) impossible. **Stereoblock** molecules, having alternate sections of clockwise and counterclockwise spirals, are intermediate between stereoregular and amorphous on the basis of crystallinity.

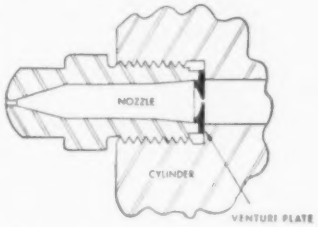
The true expert knows, however, that there's more to good polypropylene than elegant molecules. There's also the matter of special characteristics. The low ash content of Tenite Polypropylene, for instance, means low impurities and, consequently, good color. Since antioxidants added to the plastic are free of the degrading effects of ash, Tenite Polypropylene offers a high resistance to thermal breakdown. And for electrical applications, low-ash Tenite Polypropylene offers a low dissipation factor.

Word is getting around (it's true, too) that Tenite Polypropylene is an easy-to-mold plastic. Don't ask us why because we haven't the answer ourselves—just try it and we think you will be pleasantly surprised, particularly if you have an intricate or multiple-cavity mold.

THE UBIQUITOUS RESTRICTION

Injection molders have found that the naturally glossy finish of acetate, butyrate, and propionate plastic parts can be brought up to a truly mirror-like finish by dipping or spraying them with a solution of butyl acetate and acetone. These gentlemen have also found, however, that if a molded part has internal stresses, the solvent polish may act as a releasing agent and craze the surface.

The problem of internal stresses is easy to solve. A simple venturi plate—so useful for dispersing color when molding polyethylene—effectively minimizes that possibility in cellulosic parts. This orifice fits right behind the nozzle of the injection molding machine.



It has an opening 30 to 40 mils in diameter and a land of 30 mils. A land greater than 30 mils should be avoided since it might cause excessive pressure drop.

By restricting flow, the venturi plate allows cellulosic plastics to be injected at a higher melt temperature without stuffing the mold. The increase in melt temperature amounts to about 50°F.; this takes no account of additional heat due to friction at the plate. Besides permitting injection of a hotter melt, the plate also thoroughly mixes the melt. All these factors contribute to tough, attractive, and stress-free cellulosic plastic parts.

Our development laboratories are constantly working on better techniques for processing Tenite Polyethylene, Tenite Polypropylene, Tenite Butyrate, Tenite Acetate, and Tenite Propionate. For information or technical assistance, just contact your nearest Tenite representative or EASTMAN CHEMICAL PRODUCTS, INC., *Plastics Division,* KINGSPORT, TENN.

TENITE®

plastics by Eastman

Letters

Paper-Plastic Hybrid

Dear Sir:

In the December 1960 issue of the SPE Journal Newsletter, you mentioned that there is a cross linking of technology in the fields of paper textiles and plastics, which could lead to the possibility of making a hybrid paper-plastic combination; at least one company is now working on the idea.

Can you give us some more information about this, and can you tell us who that company might be?

Alan Stone
Stone Container Corp.
Chicago

Editor's Reply

Information given to the editors by the Hudson Pulp and Paper Corporation, New York, indicated that AviSun, Marcus Hook, Pa., is engaged in development work in this area. There is also reference to the development in the November 7, 1960 issue of Paper Trade Journal (page 42).

Editor's Note

Last month, an article entitled Is This Tolerance Necessary by Milton A. Sanders, Precision Molding Incorporated, was published in the SPE Journal. The article discussed unrealistic mold tolerances and specifically financial waste caused by poor choice of tolerances for molds to make missile and aircraft parts. The article was called to the attention of the Hon. Thomas Gates, Secretary of Defense. His directed reply appears below.

Defense Department Alert—

Dear Sir:

Secretary Gates asked us to reply to your letter of December 9 and to thank you for calling his attention to the article, Is This Tolerance Necessary.

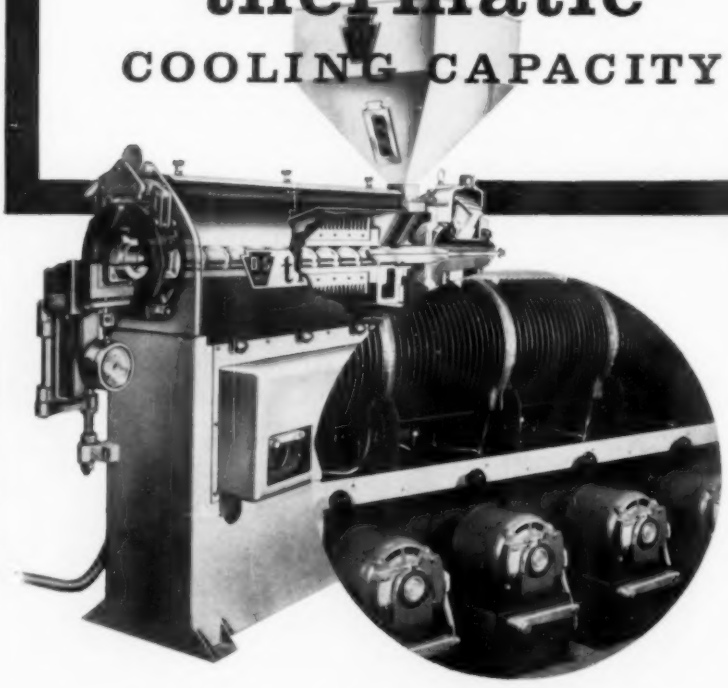
The Secretary is always pleased to see articles of current interest, and we wish to express our appreciation of your concern about the problems of the Defense Department relative to the reduction of costs of missiles and missile components. Also, we should like to assure you that this matter is under constant study, and every effort is being made to improve operating procedures in the Defense Establishment.

Thank you again for your interest.

Orville S. Splitt
Director
Office of News Services

SOONER OR LATER

BLOW MOLDERS WILL NEED thermatic* COOLING CAPACITY



*Patented

Suppose you run linear polyethylene of low melt indices from .2 to .4 . . .

D-S Thermatic cooling capacity permits lower stock temperature of the extruded tube for faster mold cycles.

On dry color blending–a competitive necessity–high screw speed for compounding is unlimited by temperature control problems due to the cooling capacity of the D-S Thermatic.

Don't lose time and money on special stock screws and slow production rates when what you really need is THERMATIC COOLING CAPACITY

D-S thermatic

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COMPANY _____

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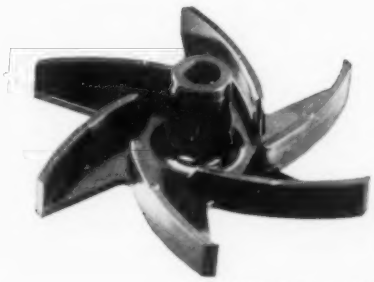
PRECISION EXTRUSION CONTROL IS OUR BUSINESS

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Phenolic for pumps**
- **Dip-coating compounds**
- **Plastic process equipment**



FLINT & WALLING MFG. CO., INC.

Why not?

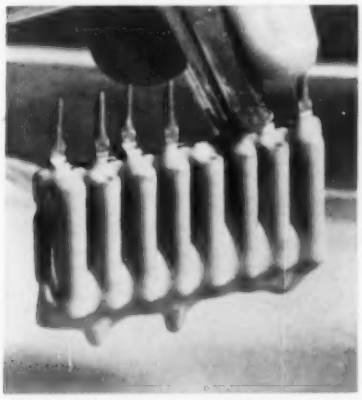
Here's a good way to engineer more profit into a pump.

The impeller is phenolic. It won't rust or corrode; it defies stubbornly the onslaughts of acid, oil, alkali, and soap.

A cubic inch of molded phenolic costs much less than you'd allow for a more traditional impeller material. Forget about machining; phenolic parts seldom need any.

If a pump must handle liquids as hot as 300°F, don't let that stop you from specifying phenolic.

We can work with your molder on the application you have in mind. Why not write us about it? Or simply check the coupon for Bulletin D400. It lists the properties of a typical Durez phenolic molding compound used in pumps, and includes much other useful information.



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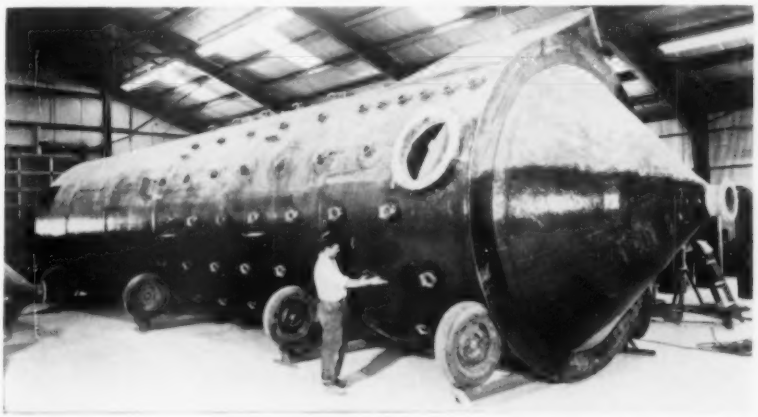

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Tentative Program

Statler-Hilton Hotel, Detroit, Mich.
March 15-16, 1961

Through its Casting and Plastics Tooling Professional Activity Group, SPE will co-sponsor with the American Society of Tool and Manufacturing Engineers, a Seminar on "Plastics for Tooling", March 15-16, 1961, Statler-Hilton Hotel, Detroit, Michigan. SPE members are eligible for the $45 member registration fee instead of the $60 non-member fee.

MARCH 15, 1961

8:30 a.m.-9:30 a.m.	**Registration and Coffee Hour**
9:30 a.m.-12:00 noon	**Engineering the Plastics for Tooling Program**
Paper No. 1	Why Use Plastics?—Advantages, economy, accuracy, reliability.
Paper No. 2	Planning and Programming Plastics for Tooling Flow studies, mock-up, study models.
Paper No. 3	The Tooling Plan: From Prototypes to Production
12:00 noon-1:30 p.m.	**Luncheon (no speaker)**
1:30 p.m.-5:00 p.m.	**Production Phases**
Paper No. 4	Foundry Pattern Applications
Paper No. 5	Tooling for Small Lot Production
Paper No. 6	Mass Casting Applications
Paper No. 7	Tooling with Reinforced Fibre Glass Plastics

MARCH 16, 1961

9:00 a.m.-11:30 a.m.	**Tour of Manufacturing Facilities —Plastics for Tooling Department** —Discussion Period
12:00 noon-1:30 p.m.	**Luncheon (no speaker)**
1:30 p.m.-4:00 p.m.	**Standards in the Industry**
Paper No. 8	Standardization of Test Methods
Paper No. 9	Physical Properties of Plastics for Tooling—Discussion Period

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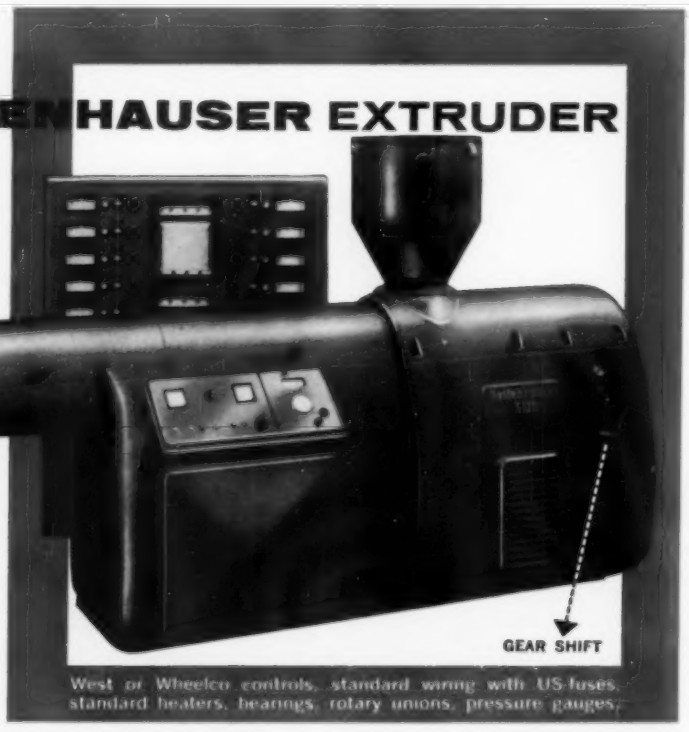

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SPE JOURNAL NEWSLETTER

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Urethane Cushioning

Molded polyether-urethane foam cushioned chairs are made in a single step by a new process. The steel frame is positioned in a mold cavity and the cushioning is foamed directly onto the tubular frame. Time needed for the polyether ingredients to blow to form the chair is only a few seconds. The new process foreshadows an even more fascinating prospect: Single step production of upholster-less furniture. General Tire and Rubber Co. developed the new chair-making method for exclusive use by Karpen Furniture.

New Instrument for Gel Rate

A new testing instrument for determining plastisol gelation has been developed (page 174). Using this gel rate approach to formulation of plastisols, a user can be assured that new formulations will perform in the same manner as his current material in a short time. The production-geared method should be of value in rotational molding, hot dip coating, slush molding, or vinyl foam applications.

Two New SPE Books

Two new books will be added to the SPE Plastics Engineering Series by the end of this year. The first, Mechanical Properties and Design Methods for Plastics Materials is being edited by Dr. Eric Baer, University of Illinois. The second—Processing of Thermosetting Resins, is edited by Walter A. Gammel, National Connector Corp.

New Developments in Phenolics

A new phenolic molding material will soon be available for applications requiring resistance to high temperatures. The new resin lasted 750 hours at 500°F before losing 20% of its weight. Commercially available phenolics lasted only 325 hours under the same conditions. Speaking of high temperatures, a phenolic resin reinforced with an organic fiber called Pluton by its manufacturer, Minnesota Mining and Manufacturing, withstands temperatures of 18,000°F.

Tritactic Polymers

Add the word "tritactic" to your polymer vocabulary. Italian polymer chemist Giulio Natta and co-workers have made optically active polymers from esters of substituted butadiene carboxylic acids. Called tritactic polymers, they have two asymmetric centers for each monomer unit.

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Union Carbide gives you a choice of polyethylenes for blow-molding —low, medium, or high density. At one authoritative source, you can expect simplified selection of the best material for your needs. And you can get expert advice in arriving at your decision.

This also includes technical aid in blow-molding your products to best advantage. Union Carbide's experience in blow-molding dates back almost as far as the technique itself. For information, write Dept. JR-132B, Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada*, Union Carbide Canada Limited, Toronto 12.

Body and legs of Madame Alexander 36" nurse doll (A) and 15" Cathy doll (B) blow-molded of Bakelite Brand high density polyethylene for Alexander Dolls, Inc., New York, N.Y. Ring (C) and bead (D) sets and wheels for toy racer (E) blow-molded of high density polyethylene by Fisher-Price Toys, Inc., East Aurora, N. Y.

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Special Feature

Plastics as Materials of Construction
-A Review

Raymond B. Seymour

Sul Ross State College

Where corrosion is a problem, plastics can be used with confidence. This article describes a number of case histories where plastics have won the battle of corrosion

One of the most successful applications of plastics in solving a corrosion problem is in the boat industry. Over 40% of all boats constructed in the U.S. in 1960 were of reinforced plastics. This trend has been given added impetus by the U.S. Navy specification that all boats under 50 feet in length are to be constructed from reinforced plastics. The U.S. Coast Guard has reported that a 40-foot reinforced plastic boat stood up well under test conditions twice as severe as those required to destroy its wooden counterpart. The Russians claim that they are now using diesel driven plastic freighters.

The survival of the free world may depend on the design of our future submarines, missiles, and space ships. Engineers in these fields were quick to recognize the advantages of plastics over conventional materials of construction. Conning towers for the U.S. Halfbeak and Skate utilized plastics as materials of construction. Also the 400 square foot sonar windows of these vessels are made from plastics.

Plastic life buoys weighing one third as much as previous structures are now floating in the North Sea. Plastic pontoons are basic in the design of new small boat harbors. Wood chips are now transported down stream in 8 ft. reinforced plastic spheres.

The use of reinforced phenolic resins as ablative materials has been well documented. Peroxy acid type epoxy resins have also shown promise in high temperature applications (8). The strength to weight ratio of two million is now in prospect. A ratio one million for plastics compared to 570,000 for steel is now assured.

The large galleys on the DC-8 jet is an excellent example of the application of plastics as functional materials (6). The use of epoxy resin-coated filament winding has reduced human error and has assured uniformity and strong structures. Pressure vessels based on filament winding and tanks with capacities of 20,000 gallons are now available (9).

Unique Buildings Created

Creative thinking comparable to that applied in missile and space age research is acceptable for the design of structures outside this nation's metropolitan areas. Radome structures 140 feet in diameter constructed from cellular plastic panels have assured the designers that 15 story plastic buildings are both practical and weather resistant (5). Plastic structures at foreign exhibits have been equally impressive.

Air supported structures considered primarily as temporary shelters are serving as factory buildings. Inflated vinyl coated nylon pentadomes with diameters as great as 140 feet with heights of 85 feet are also in use.

Because radome structures are serving so well under unusual weather conditions builders are increasing their use of cellular polystyrene as insulation material. Over one hundred million board feet of this type insulation will be used in Canada this year (3).

Progressive builders are impressed with the advantages offered by plastics in residential construction. One builder in the Pittsburgh area plans to build 1500 dwellings in the absence of code restrictions. He has invited members of the plastics industry to recommend a plastics approach. It has already been demonstrated that frame houses can be erected in less than 5 hours using plastic panels.

Other builders have utilized plastics as forms for casting concrete. Reinforced plastic panels are being used to cast concrete waffle type flooring. These forms can be reused as many as 15 times. In other instances the plastic structures are allowed to remain in place after being filled with concrete. When the concrete is not exposed, these structures have improved resistance to moisture and corrosives. Fiberglass coated with epoxy resin is also used to reinforce concrete structures.

Fortunately, strong film and sheeting is also available for this type application. Biaxially oriented polyethylene has 7 to 10 times the strength of polyethylene. Because of its excellent resistance to tear and its ability to shrink uniformly when heated, stretched irradiated polyethylene is also of interest.

The first basic change in shotgun barrels in the twentieth century was made possible through the use of plastics. In this development, about 500 miles of resin impregnated glass fiber is wound around a thin metal tube to yield a barrel with twice the bursting strength of the conventional gun barrel (11). Equally ingenious is the use of interlocking sections of reinforced plastic duct rods in the installation of underground cable.

Applications in corrosion engineering are less glamorous but equally important. The Engle process in which finely divided polymers are fused on contact with hot surfaces is just one example. This technique has been used to construct 1000A gallon tanks from polyethylene, polypropylene, and nylon (7). Since polyethylene will adhere tenaciously to a copper oxide surface, this process can also be used to construct polyethylene lined tanks (4). The addition of diisocyanates to polymers also improves adhesion (1).

Possibilities Unlimited in Transportation

Larger tanks have been constructed from reinforced polyester and epoxy resins. All ingredients can be applied simultaneously through the use of specially constructed guns. Bulk shipping containers measuring 24 ft. x 8 ft. x 8 ft. with a capacity of 40,000 lbs. have been made from reinforced plastics (2). Stronger structures are possible through the use of filament winding.

Reinforced plastic tank trucks are now used to transport ice cream, cold orange juice, and hot glucose. Some of these trucks are equipped with plastic diesel fuel tanks. Creative design is limited by the shape and material of construction of a conventional tank truck, but the use of reinforced plastics makes rectangular light weight tanks feasible. Thus, both the design and the material of construction make possible greater service and economies for another industry.

The trucking industry is plagued by costly dead hauls, with empty flat bed trucks. Pillow tanks weighing about 900 lbs. which can be folded to form a package 7½ ft. x 2½ ft. are now available. These collapsible tanks made from rubber coated nylon have capacities as high as 3000 gallons. This same design has been used for the construction of 50,000-gallon storage tanks. Tanks three times this size can be constructed if needed. Similar construction has been used to fabricate 30 foot tubes, 150 feet in length which are inflated to form impromptu dams on the Los Angeles River.

In spite of their lack of knowledge of the chemistry of plastics, foundry personnel have welcomed the use of plastics for shell molding, cores and patterns. Cooling towers which depended on the use of wood for years, now include 9 ft. sq. molded sections of polyethylene. Fume scrubbers 50 ft. high and 10 ft. in diameter are not uncommon. Likewise, the installation of large plastic fume ducts, stacks and roof ventilators is now routine.

The installation of plastic sea gates 12 ft. x 26½ ft. off the shore of Southern California presented few unusual problems because these strong corrosion resistant structures were light in weight. In contrast, the installation of heavy 12 ft. diameter concrete pipe in the same area was impressive. Breakage of pipes during installation was prevented through the use of reinforced plastic bumpers at the bell ends (10).

Noah caulked his ark with the only plastic available at that time. Plastic caulking materials are equally important today. Over 200 gallons of Thiokol-based putty were used in the installation of the large stained glass window in the American Air Lines building at the New York International Airport. Over 100,000 sq. ft. of sidewalk in the San Francisco business section was made waterproof and slip resistant by use of epoxy resin cement. Similar techniques were used to provide skid resistant surfaces on ramps and bridges in Pittsburgh, Pa. and Needham, Mass. (13).

Over 10 million pounds of polyester plastic cements are used annually in diverse applications ranging from car body repair to patching chemical processing equipment (12). Similar techniques were used to join reinforced plastic panels in the construction of a 120 ft. acid fume stack.

Old Industries Add New Impetus

During the early days of plastics development, a few engineers associated with classical materials considered plastics as competitive materials and hence refused to consider them in the solution of their problems. Today, all informed technologists recognize that the solution of the problem is more important than the preservation of older arts. In many cases a dying industry has been revived through the use of a combination of plastics and classical materials. Many jobs and reputations have been saved by the insertion of polyethylene tubing in a perforated alloy pipe.

The clay pipe industry has used filled resinous joints for many years. Hence, it not only welcomed the opportunity to use superior plastic pipe joints but actually was responsible for their development. Vinyl plastisol joints and polyester-rubber gasket joints have been used successfully for several years. Over 100 million pounds of plastics have been used to date by this industry and this use is increasing. The clay pipe industry like other modern industries has accepted the policy of "using each functional material where it is best suited". Thus, complicated clay pipe fittings such as T's etc., are made by joining simple sections with epoxy resin cements.

The knowledge that the annual plastics production will exceed 10 billion pounds by 1970 is reassuring to those who have fostered the sound technical programs that have nourished this industry. The relative percentage used in each major application in the future will depend upon the mutual understanding of supplier and user.

Literature References

1. Blaich, C. F., and Sampson, A. J., *SPE Journal*, *16*, 206 (1960)
2. Butler, H. G. & Hawkins, A. W. 15th Annual Meeting, Reinforced Plastics Div., SPE, Feb. 1960, Chicago, Illinois
3. *Canadian Plastics*, Jan. 1960, P.43
4. *Chemical Engineering News*, 38, No. 16, 96 (1960)
5. Fretz, G., 15th Annual Conference, Reinforced Plastics Division SPI, Feb. 1960, Chicago, Illinois
6. Goldsworthy, B., *Western Plastics 7*, No. 2, 9 (1960)
7. *Materials in Design Engineering*, *51*, No. 3, 10 (1960)
8. Miller, S. A., & Chase, S. A., *Materials in Design Engineering*, *51*, No. 4, 17 (1960)
9. Norden, R. B., *Chemical Engineering*, *67*, No. 8, 214 (1960)
10. Oye, L., 15th Annual Conference, Reinforced Plastics Division SPI Feb. 1960, Chicago, Illinois
11. Silva, J. W. 15th Annual Conference, Reinforced Plastics Division SPI, February 1960, Chicago, Illinois
12. Szymanski, W. A., Corrosion, *16*, No. 3, 22 (1960)
13. Williams, R. N. *Modern Plastics*, *37*, No. 7, 102 (1960)

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SPEAKING OF EXTRUSION

Paste Extrusion of Filled TFE-Fluorocarbon Resin For Wire Insulations

A study of the preparation and properties of high temperature insulated wire with improved abrasion and cut-through resistance

Certain applications for insulated wire require greater resistance to abrasion and cut-through than is offered by conductors insulated with unmodified fluorocarbon resins. These areas, therefore, offer potential markets if abrasion and creep resistance can be improved. Previous work, with moldings of granular TFE resins, has shown that abrasion resistance and creep, which is related to cut-through resistance, can be improved by blending the resin with fillers.

The purpose of the work reported in this article was twofold. The first objective was to determine the processability of "Teflon" 6[1] resin blended with various fillers and paste extruded as wire insulation. The second objective was to measure the effect of the fillers on abrasion resistance, cut-through resistance and electrical properties of the insulations of filled tetrafluoroethylene resin.

Background Information

TFE fluorocarbon resins have excellent physical and electrical properties which make them ideal insulating materials. Of several methods of fabricating insulations of TFE resins, the paste extrusion process reported here is the one most often used to manufacture high temperature insulations of TFE fluorocarbon resins.

The paste extrusion process is similar to stuffer pressing or cold extrusion of metals. It is a batch process where a charge of TFE resin blended with an organic extrusion aid is forced from an extrusion cylinder thru a die.

The TFE extrusion powder which has been blended and preformed to the shape of the extrusion cylinder is placed in the extruder. The wire is introduced into the extruder cylinder through a wire guide tube and a guide tube tip. The wire is coated with resin at a point near the top of the conical die as pressure is applied to the preform by a ram. The extrudate passes through an oven heated to 350 to 575°F, where the lubricant is volatilized. It then passes through a second oven heated to 650 to 750°F, where the coating is sintered or fused. The capstan, wind-up, pay-off, and spark testing equipment used are

Table 1. Fillers Evaluated.

A wide variety of shapes and particle sizes were chosen

Filler	Specific Gravity	Particle Size (μ)
Asbestine® (fibrous magnesium silicate)	2.76-2.85	98% <20
Asbestos	2.44	96% $<1.39 \times 10^3$
Cab-O-Sil® (silica)	2.1	0.015-0.020
Calcium Silicate	2.92	95% <62
Fiberglas® (glass fiber)	2.55	$50 \times 0.79 \times 10^3$
Graphite	2.26	99% <74
Talc	2.76	89% <44
Quartz	2.16	149-250

ASBESTINE®—International Talc Company
CAB-O-SIL®—Godfrey L. Cabot & Sons
FIBERGLAS®—Owens Corning Fiberglas Corp.

[1] Trademark of E. I. du Pont de Nemours & Company, Incorporated. Teflon 6 will be referred to as "TFE Resin" in the rest of the article.

common wire coating equipment. One of the important variables in the paste extrusion process is the reduction ratio. This is the cross-sectional area of the TFE resin in the extrusion cylinder divided by the cross-sectional area of the TFE resin in the die. Other important variables which affect extrusion pressure are the die land length, the included angle of the die, and the distance between the end of the guide tube tip and the entrance to the die land.

Fillers Tested

Since this investigation was of a scouting nature, the fillers were chosen with particle characteristics ranging from very small, hard, spherical particles to large fibrous particles. For the most part, the particle size used was the smallest available for the filler being investigated. Some of the fillers such as asbestos and glass fiber were chosen because they have been used successfully as fillers for molded TFE granular resins. Asbestos of the blue African type was selected. This is a crocidolite variety which is dry and acid resistant.

Table 1 lists the fillers which were evaluated, their particle sizes and specific gravities. Asbestine® is a fibrous magnesium silicate talc with an average particle diameter of 3 microns. Cab-O-Sil® is a finely divided silica. Fiberglas® is a rod-shaped particle 0.030" by 0.002".

Blending Techniques

Most of the fillers were dry blended with TFE resin by mechanically rolling in a gallon jar for five minutes. The lubricant was then added and the mixture blended by rolling for fifteen minutes. Because of processing difficulties, the glass fiber was dry blended under nitrogen at −40°F and the silica was mixed with a TFE resin dispersion, coagulated and dried.

Constructions Evaluated

The wire constructions which were produced in this work are listed in *Table 2*. The last two were achieved by a process we call concentric extrusion, which was developed to permit the simultaneous extrusion of two separate layers of insulation. Either the primary or the jacketing layer can be extruded from filled TFE resin. This simultaneous extrusion is achieved by employing a preform with a core and outer surface of different filler contents. *Figure 1* is a drawing of a preform die for concentric extrusion.

The constructions listed in *Table 2* were chosen to determine the extrudability of filled resins at high and moderate reduction ratios into constructions with thick and thin insulations. All of these constructions were fabricated using a 1.5" diameter extrusion cylinder. The 10-mil insulation over a 15-mil wire (E-28 type construction)[1] is difficult to extrude, because it is a thin insulation on a fine wire, and the resin must undergo a severe area reduction (1600 to 1) during processing. Therefore, any effect of the fillers would be accentuated. The 10-mil insulation on a 30-mil wire (E-22 type construction)[1] has a reduction ratio of about 900 to 1. The 15-mil insulation on a 15-mil wire (EE-28 construction)[2] has a reduction ratio of about 850 to 1, but is less critical than the E-22 because of the heavier wall. The jacketed constructions were prepared to evaluate the improvement in physical properties offered by filled insulations without affecting the electrical properties.

[1] Military Specification MIL-W-16878/5 "Navy", for 200°C, 600 volt wire constructions.

[2] Military Specification MIL-W-16878/6 "Navy", for 200°C, 1000 volt wire constructions.

Processability

Magnesium silicate, talc, and graphite fillers, when blended with TFE resin, had the least effect on processing. The processing results are shown in *Tables 3 and 4* which group the results according to the construction evaluated. The TFE resin could be blended and processed to a higher filler loading with magnesium silicate, talc and graphite than with the other fillers evaluated. The fillers which permitted the best extrusion performance when blended with TFE resin had an average particle size near that of the TFE resin and were fibrous or easy to shear (*Table 1*).

None of the fillers evaluated could be processed as E-28 constructions. This was probably because the E-28 construction has a high reduction ratio. The magnesium silicate, calcium silicate, and talc all processed

Table 2. Constructions of TFE Resin Evaluated.

Extrusion reduction ratios, insulation thickness and numbers of layers are varied

Primary	Jacket	Conductor Diameter	Specification Code
0.010" Filled TFE Resin	—	0.015"	E-28
0.010" Filled TFE Resin	—	0.030"	E-22
0.015" Filled TFE Resin	—	0.015"	EE-28
0.010" Unmodified TFE Resin	0.010" Filled TFE Resin	0.015"	
0.006" Unmodified TFE Resin	0.004" Filled TFE Resin	0.030"	
0.004" Filled TFE Resin	0.006" Unmodified TFE Resin	0.030"	E-22 Concentric

Table 3. Processability of Simple Extrusions.

Magnesium silicate, calcium silicate and talc gave the best results

Filler	% Filler	EE-28 Construction % Yield/Remarks	EE-22 Construction % Yield/Remarks
Magnesium Silicate	2.5	90/Smooth extrudate	
	5.0		93/Smooth extrudate
Asbestos	2.5	0/Sheared at die	
Silica	2.5	0/Continuous spark failure	0/Continuous splits
	5.0		0/Sheared at die
Calcium Silicate	2.5	72/Random pin holes	0/Sheared at die
	5.0		
Talc	2.5	100/Slight surging	
	10.0		0/Sheared at die
Glass Fiber	2.0	0/Resin agglomerated	
Quartz	2.5	0/Filler protruded	

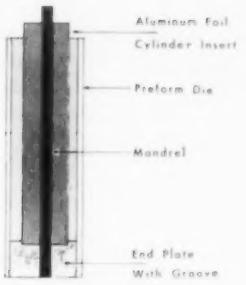

Figure 1. Preform die for concentric extrusion permits simultaneous extrusion of filled and unfilled TFE resin jackets on the same wire

well as EE-28 type constructions when blended with TFE resin to a concentration of 2.5% filler. (*Table 3*). The asbestos and glass fiber caused the TFE resin to be oversheared, as it was forced through the die. This resulted in longitudinal splits and cracks in the insulation. Several modifications in extrusion technique were made to reduce the extrusion pressure to overcome this problem but to no avail. Because of the small particle size, and therefore extremely large surface area of the fine silica, this filler absorbed too much of the lubricant and the mixture with TFE resin was too dry for extrusion at practical pressures. At higher lubricant concentrations (25%), the silica-filled resin could be processed but still suffered in severe working during extrusion. The quartz-filled resin extruded satisfactorily but the quartz particle was so large that it protruded.

The E-22 construction represents a moderate reduction ratio extrusion of a thin-walled insulation. The magnesium silicate at 5% loading was the only filler which processed well in this construction (*Table 4*).

A 10-mil jacket of filled TFE resin was applied over a previously extruded primary of pure TFE resin to find out if lower reduction ratios would permit higher loadings of filler to be used. A construction such as this would also offer improved physical properties without sacrificing the electrical properties of the "Teflon" resin. The magnesium silicate and talc extruded well at loadings up to 5% and 10% respectively. (*Table 4*). The insulation was rough with the high loading of talc, but the flaw-free yield of wire in lengths greater than 50 feet was 80%.

Graphite and magnesium silicate are the only two fillers which were evaluated in the E-22 construction prepared by concentric extrusion. The choice of these two fillers was based on their extrusion performance in other constructions and the property improvements desired. A graphite filled primary was extruded simultaneously with a jacket of pure TFE resin from a single preform. We hoped that this construction would allow the primary to act as a semiconductor and thus offer increased resistance to corona attack. This did not occur because the highest concentration of graphite which would extrude well did not lower the surface resistivity of the blend to the required 1 megohm per square.

A jacket of magnesium silicate filled TFE resin was extruded simultaneously with a primary of pure TFE resin. This construction offered improved physical properties with little effect on the electrical properties. The processability results of these concentric extrusions are shown in *Table 4*.

Effect of Fillers on Electrical Properties

In almost all cases, the addition of filler has some adverse effect on the electrical properties of TFE resin. The electrical tests performed and the

Table 4. Processability of Overcoat and Concentric Extrusions. Graphite, magnesium silicate and talc gave the best results

		10 mil Filled Over 10 mil Unfilled	E-22 Concentric
Filler	% Filler	% Yield/Remarks	% Yield/Remarks
Graphite	10.0		90/Smooth Extrudate
	20.0		0/Rough Extrudate
Magnesium Silicate	5.0	90/Smooth Extrudate	86/Smooth Extrudate
	10.0	0/Continuous Failure	0/Sheared at Die
Silica	5.0	0/Jacket Split & Cracked	
Calcium Silicate	5.0	0/Jacket Split & Cracked	
Talc	10.0	80/Rough Coating	

Table 5. Electrical Properties of Simple Filled Insulations

Sample	% Filler	Insulation Resistance (Ω/1000′)	Dissipation Factor	Dielectric Strength (KV)	Dielectric Constant
Construction—EE-28:					
Control		1.1×10^{13}	<0.0001	8.5	1.82
Calcium Silicate	2½%	1.8×10^{13}	0.0034	3 KV for 5 sec.	5.02
Talc	2½%	1.3×10^{13}	0.0120	8	3.55
Asbestine®	2½%	1.8×10^{13}	0.0073	7.5	3.06
Construction—E-22:					
Control		2.0×10^{13}	<0.0001	8.0	1.73
5% Asbestine®		1.7×10^{11}	0.017	8.0	3.55

Table 6. Electrical Properties of Two Layer Filled Insulations

Sample	Insulation Resistance (Ω/1000′)	Dissipation Factor	Dielectric Strength (KV)	Dielectric Constant
Construction—Concentric Extrusion				
Control	2.0×10^{13}	<0.0001	8.0	1.73
10% Graphite center core	—	0.0019	2.5 KV for 20 sec.	2.12
5% Asbestine® outer ring	8.4×10^{10}	0.0075	5.5	1.72
Construction—10 mil unfilled primary with filled jacket				
Control	1.1×10^{11}	0.0012	11.7	2.04
10% Talc	1.3×10^{12}	0.0095	10.0	2.01
5% Asbestine®	2.1×10^{12}	0.004	12.0	2.00

Table 7. Abrasion Resistance of TFE Insulated Wire, Showing Improvement Caused by Fillers.

	Abrasion, Resistance, Inches of Tape[1]			
Construction:	EE-28	10 Mil Filled Over 10 Mil Unfilled	E-22	E-22 Concentric
Filler:				
Control	50	49	24	24
Calcium Silicate 2.5%	71			
Magnesium Silicate 2.5%	59			
5%		57	31	60
Talc 25%	55			
10%		62		

1. Inches of weighted abrasive belt passing over insulation to wear through to make electrical contact with wire. (NAS 703)

results are shown in *Tables 5 and 6*. All of the constructions produced were subjected to a four-hour soak in water containing a wetting agent, followed by an electrical stress for one minute (2.5 KV for 10-mil insulations, 3 KV for 15-mil insulations). All of the samples passed except those containing calcium silicate and graphite.

At a loading of 2.5%, none of the fillers affected significantly the insulation resistance of a 15-mil coating. The calcium silicate filled insulation failed the tank test and exhibited a severe increase of dielectric constant over that of the control. Talc increased the dissipation factor more than did the other fillers. Magnesium silicate showed the least effect on electrical properties. However at high loadings in thin wall constructions, magnesium silicate also seriously reduced the electrical properties of TFE resin (*Table 5*).

The adverse effect of fillers on electrical properties is reduced by applying a jacket of filled TFE resin over a primary of a pure TFE resin (*Table 6*). None of the constructions in the previous tables met the electrical specifications of MIL-W-16878.[1] However, by using this jacketing technique, the 5 per cent magnesium silicate filled insulation meets this specification, and the 10 per cent talc filled resin is only slightly over the maximum allowed dissipation factor.

By using the technique of concentric extrusion, a 4 mil primary of unmodified "Teflon" 6 resin with a 6-mil jacket of a filled TFE resin was produced. This construction displayed electrical properties almost as good as the 10-mil primary and 10-mil jacket (*Table 6*). The graphite filled resin exhibited poor dielectric strength because the jacket of virgin TFE resin was too thin. A thicker layer of unmodified TFE resin would have made it impossible to extrude the graphite filled primary.

[1] Electrical Requirements of MIL-W-16878 are:
A. Minimum insulation resistance—1 x 10^9 ohm/1000 ft.
B. Maximum dissipation factor—0.005
C. Maximum dielectric constant—2.5
D. Minimum dielectric strength—2.2 KV for E-type, 3.0 KV for EE-type.

Abrasion Resistance

Abrasion resistance was measured according to the procedure described in paragraph 4.3.11 of the National Aircraft Standards Committee specification for high temperature hook-up and general purpose insulated wire (NAS 703). The test is described and the effects of fillers on the abrasion resistance of the constructions evaluated are shown in *Table 7*.

All of the filled compositions (2.5% filler loading) that could be fabricated as EE-type constructions had better abrasion resistance than the unfilled control. The calcium silicate offered the most improvement (40%) but was one of the most difficult to process. The magnesium silicate filled resin processed well and improved the abrasion resistance up to 20%.

Resin with higher filler loadings could be processed as a 10-mil jacket over a previously extruded primary of unmodified "Teflon". The higher filler concentrations (5-10%) in 10-mil insulations offered as much or more abrasion resistance as 15 mils of low (2.5%) filler concentrations This was also true for 10-mil primaries (E-22 construction).

The 10-mil E-22 concentric insulation, which was made up of a 4-mil primary of unmodified "Teflon" and a 6-mil jacket of filled TFE Resin extruded simultaneously, improved the abrasion resistance by 150 per cent. This startling improvement may be due to the cushioning effect of the unmodified resin under the abrasion resistant filled resin.

Cut-Through Resistance

Two types of cut-through tests were used to evaluate the effect of fillers: the room temperature cut-through test, and the high temperature cut-through test.

The former was performed according to the procedure described in the proposed Underwriters Laboratories Slow Compression Test. The addition of fillers improved the cut-through resistance only for EE-type constructions Only the resins blended with 2.5 per cent calcium silicate or "Asbestine" gave improved cut-through resistance in the EE-28 construction. None of the other fillers and constructions investigated offered any improvement.

The high temperature cut-through test was run according to a modification of the proposed Underwriters Penetration Test. The data indicated that the fillers improved the high temperature cut-through resistance of EE-type insulations of TFE resin.

Summary

The abrasion resistance of insulations of paste extruded TFE resin is improved 10 to 150 per cent by blending fillers with the resin prior to lubrication and extrusion. By using special constructions, the addition of filler has little or no effect on the electrical properties of the insulation. In EE-type constructions (15-mil wall thickness), the room temperature cut-through resistance of some insulations was improved 30 to 50 per cent by the addition of fillers. The high temperature cut through was much better with the filled insulations than with the insulations of pure TFE resin.

The upper limit of filler concentration for good extrusion performance was 2.5 to 10 per cent, depending on the wire construction and type of filler used. The filler materials used were: asbestos, calcium silicate, graphite, talc, quartz, glass fibers, finely divided silica, and fibrous magnesium silicate.

From this evaluation it appears that "Teflon" 6 resin filled with fibrous magnesium silicate offers the easiest extrusion, the most improvement in abrasion resistance, and the least effect on electrical properties. The process of simultaneously extruding a primary and a filled jacket affords a means of improving physical properties without affecting electrical.

Edited by **Bruce H. Maddock**,
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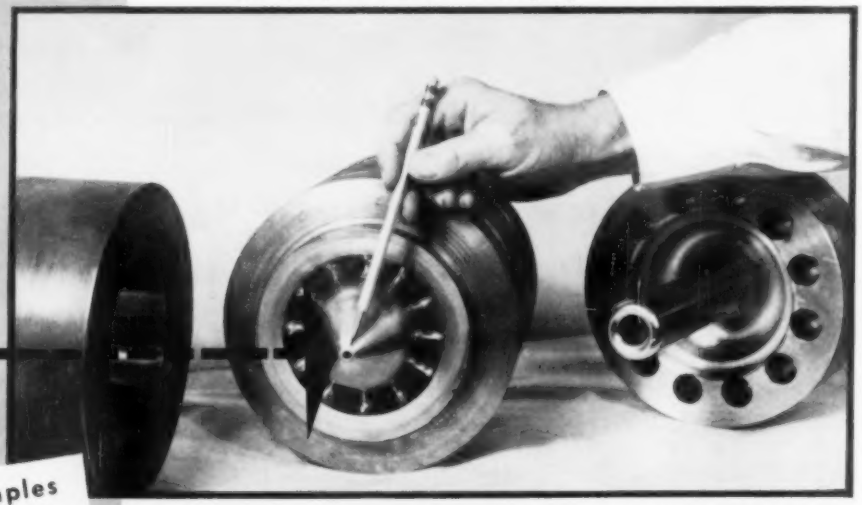

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MOLDING CYCLES

Dimensional Control of Acetal Moldings

This article describes 10 steps for the economical control of dimensions of acetal parts

The high strength, excellent heat resistance, and unusual chemical resistance of acetal resins make moldings of these resins ideal for engineering applications. In many instances these applications call for close dimensional control of such order as to require more than a normal amount of analysis and study. A thorough knowledge of the factors which create dimensional variation is necessary if the costly, time consuming technique of trial and error is to be avoided. Most important is a knowledge of the behavior of the material during processing. Because without this, the molder will be working completely in the dark.

Eliminating the Variables

Acetal resins differ from most other materials in one very significant property: The apparent viscosity in the safe processing range is very uniform reducing the processing problem to one relatively independent of stock temperature. Thus what appears to be a narrow range of working temperature between melting point and decomposition is actually a very comfortable area in which time only is the control factor. To avoid high temperature gradients which would lead to breakdown and loss of properties, hold-up time in the heating cylinder is utilized to guarantee full melt condition. The importance of efficient, streamlined heating cylinders cannot be overstressed.

For proper analysis of the problem the variables should be grouped by function. The first group of variables centers about the molded part, the most important of which is average thickness. Range of thickness is important in determining the extremes of shrinkage with possible post-molding stress relief being dictated. Flow distance is secondary in effect in that it will influence mold temperatures and pressures.

The second group of variables is contained within the mold, the most important single factor being the gate. *No other single factor has as much influence on dimensional control as the gate* (see Figure 1). Gates must be designed into the mold rather than just cut at random if the final product is to gain the advantage of the material's inherent properties. Too small a gate will cause excessive shear in the material leading to serious loss of properties while too large a gate will call for pressure dwell time of such order as to create frozen-in stress and subsequent dimensional instability. Second in importance in the mold is temperature whose influence is felt in environmental stability after molding. The remaining variables lie within the machine.

The economical control of dimensions dictates the elimination of as many variables as possible at the very start of the analysis. The limits of acceptance should be established as realistically as possible and attention directed toward the critical points first. The following sequence of steps is recommended for control:

1. Isolate the critical dimensions and average thicknesses.
2. Determine the gate size as half the average thickness but not less than .040 x .040. (Gates smaller than .040 in thickness border on the critical limit for jetting and create additional variables.) For thicknesses greater than .25 use gates .125 + .015 for each additional .062 of thickness. Thus, a thickness of .375 would have a gate of .125 + .03 or .155.
3. If the gate is to be round calculate the area of gate using the values in (2) above as diameter.
4. Using the values given by the resin manufacturer establish the

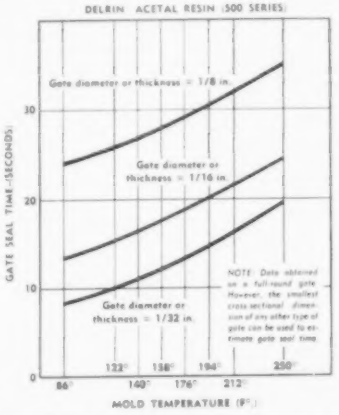

Figure 1. Gate seal time vs. gate size and mold temperature.
(Courtesy of E. I. du Pont de Nemours & Co., Inc.)

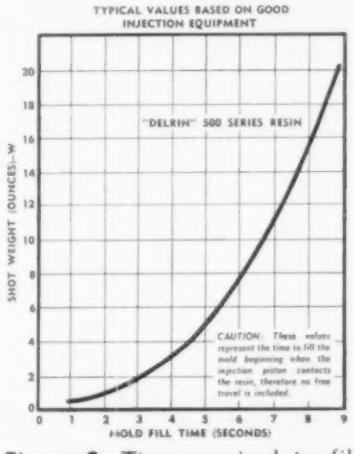

Figure 2. Time required to fill mold.
(Courtesy of E. I. du Pont de Nemours & Co., Inc.)

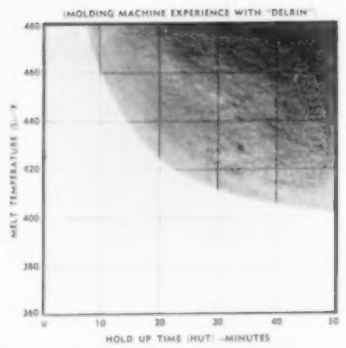

Figure 3. Limits of hold up time vs. temperature. Satisfactory time-temperature conditions are shown by lighter area. As color intensity increases, possibility of yellow streaking and overheating increases.
(Photo courtesy of E. I. du Pont de Nemours & Co., Inc.)

preliminary value of shrinkage.

5. With the gate size established, determine from the material mfrs. data the gate seal time using 170°F as the initial mold temp.
6. Add two seconds to the gate seal time to allow for free travel and determine the cooling time as one minute for each ¼" of thickness (use maximum section thickness rather than average).
7. Add opening and closing time and determine the total cycle.
8. Determine the shot weight and divide it into the heating cylinder capacity (machine capacity) and multiply by six. (Six is chosen as an average of the ratio of storage capacity to maximum shot capacity for most machines).
9. The value in (8) will determine the number of shots necessary to completely purge the heating cylinder and if this value is multiplied by the cycle time, the hold-up time in the cylinder is determined. The data given by the mfr. will show the safe material temperature for the particular hold-up time.
10. The above steps will establish the initial conditions for molding. At this point the molder must again review the part design to determine the level of control needed.

Secondary Operations

Molded-in dimensions are always preferred to those obtained through post-molding operations since surface conditions are normally better and stability is usually greater. However, when the tolerance range is less than .004"/inch it will probably be more advisable to provide for secondary operations. It would also be wise to provide for annealing of the part prior to secondary operations since stress relaxation will occur after post-molding operations if there are frozen-in stresses in the molded part. Stress relaxation shrinkages prior to post-molding operations average .001"/inch while expansion due to post-molding machining averages .002"/inch. To avoid the vagaries of stress relaxation it is preferable to use the highest possible mold temperatures and let the part anneal in the mold. The quality of the part is inevitably higher and control better.

After the first moldings are obtained in the trial runs the molder can determine whether there are any radically incorrect conditions and make his initial corrections. (It should be noted that in many instances the above procedures have yielded finished parts with little or no change being needed in anything but the gate thickness.) Following these corrections, the application of quality control charts will provide accurate and direct information as to the level of control being obtained. *Dimensional control of high order cannot be obtained without using the tools of the engineer and the statistical methods of the quality control specialist.* (As a guide the molder is directed to the text on quality control, SPE series.)

Certain limitations to control must be recognized at the outset. Because of the high mold temperature normally used for the acetals, the expansion of the mold must be considered in establishing mold dimensions. Steel expands .6 × 10^{-6}"/inch/°F and alignments within the mold must be carefully considered if any appreciable differences in mold temperature exist. While this condition is true for molding other materials, it is particularly true for the acetals because their sharp melting point and high distortion temperature makes them reproduce the mold dimensions more religiously. It is suggested that center distances of round holes be very carefully studied before they are incorporated in the mold. Secondary drilling is often more reliable because of the expansion of the steel mold.

When the level of control has been determined by the initial moldings, the direction of adjustment should be studied thoroughly before any changes are made. As a safeguard, a dimensional analysis should be made before annealing and then the same analysis made after annealing to make certain that stress relaxation does not disturb the end results. If the dimensions are found to be greater than required they can be reduced by shortening either injection dwell time or cooling

(Continued on page 199)

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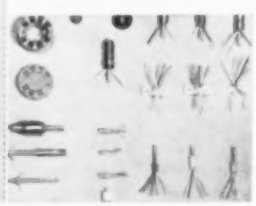

Frank W. Reinhart

Chief, Plastics Section, National Bureau of Standards

STANDARDS FOR PLASTICS

Standards for Plastic Pipe and Fittings

A survey of current standards and work in progress on new ones for an important application of plastics

There is a strong, active program underway in the USA to develop standards (test methods, specifications, nomenclature, codes, and installation manuals) for plastic pipe and fittings. The development of good standards in this area is very difficult because of the critical nature of some of the applications, the lack of sufficient knowledge about the stress-strain-time relations and failure mechanisms of plastics, and the lack of long-time service experience. The issuance of high-quality standards will do much to engender the confidence of architects, designers, builders, building officials, and potential users in plastic pipe and thus open the way for increased volume in this part of the plastics industry. The development of quality standards is a major technical problem and requires the attention of highly qualified engineers and scientists to fully utilize all the scientific knowledge and experience available

This article will summarize the status of the work on plastic pipe and fittings standards and to indicate major areas in which work is underway. Each organization sponsoring major programs will be dealt with in turn.

The Thermoplastic Pipe Division of the Society of the Plastics Industry (SPI) is developing Commercial Standards for plastic pipe and fittings. Commercial Standards are developed by industry committees in cooperation with the Commodity Standards Division, Office of Technical Services of the U.S. Department of Commerce and with technical advice from the National Bureau of Standards (NBS). They are promulgated by the U.S. Department of Commerce. The SPI Thermoplastic Pipe Division is composed of manufacturers of plastic pipe and fittings. The author is Technical Consultant to this program. The Commercial Standards developed to date are as follows:

CS 197-60 Polyethylene Plastic Pipe

CS 206-57 Solvent Welded (SWP Size) Cellulose Acetate Butyrate Pipe

CS 228-60 Plastic Drain and Sewer Pipe and Fittings

CS 207-60 Rigid Unplasticized Polyvinyl Chloride Pipe

CS 226-59 Laminated-Wall, Bituminized-Fibre Drain and Sewer Pipe (Ed. note: not sponsored by SPI)

SC 218-59 Rigid Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (IPS Size Dimensions)

CS 219-59 Dimensions and Tolerances for Solvent-Welded (SWP Size) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe

CS 220-59 Dimensions and Tolerances for Light Weight Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe

Work is underway in the SPI Thermoplastic Pipe Division on revisions of all these Commercial Standards to increase and improve the quality requirements, and to expand the scopes in regard to sizes and materials. A new tentative method for estimating long-term strength and working stress for thermoplastic pipe has passed a Division letter ballot. This method will be used by the Division to assign working stress values to plastic pipe materials. In addition, standards for pipe fittings and installation manuals are being developed. A program has been established to achieve a high degree of coordination between the SPI and ASTM by the creation of small joint ad hoc task groups.

The thermoplastic pipe and fittings standards work in Committee D-20 on Plastics of the American Society for Testing Materials (ASTM) is concentrated in Subcommittee XVII on Thermoplastic Pipe and Fittings which is a joint SPI-ASTM group. The activity on reinforced thermoset plastic pipe is done in Section B on Reinforced Pipe and Fittings of Subcommittee XVIII on Reinforced Plastics. This is also a joint SPI-ASTM group, with strong representation from the American Petroleum Institute. The ASTM standards already issued are as follows:

D 1694-59T Threads for Reinforced Thermosetting Plastic Pipe

D 1503-57T Solvent Welded (SWP Size) Cellulose Acetate Butyrate Pipe

D 1527-58T Iron Pipe Size (IPS) Extruded Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Dimensions of

D 1528-58T Solvent Welded (SWP Size) Extruded Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Dimensions of

D 1598-58T Time-To-Failure of Plastic Pipe Under Long-Term Hydrostatic Pressure

D 1599-58T Short-Time Rupture Strength of Thermoplastic Pipe, Tubing, and Fittings

D 1785-60T IPS Rigid Poly(Vinyl Chloride) (PVC) Plastic Pipe

New specifications for polyethylene pipe, polyvinyl chloride fittings, and

ABS solvent adhesives, and new test methods for impact resistance, chemical resistance, and stress cracking are being developed in ASTM Committee D-20 on Plastics. Revisions of the specifications for PVC and ABS pipe and of test methods D 1598 and D 1599 are also being prepared. Subcommittee XVII has started to study the tentative method for estimating long-term strength and working pressures that was developed in the SPI Thermoplastic Pipe Division with a view to developing and refining it further and issuing it as a joint SPI-ASTM standard. Groups are being established to prepare test methods and specifications for sewer, drain and vent pipe, and electrical conduit.

Section XVIII B in ASTM Committee D-20 is developing test methods for tensile properties, crush strength, and cyclic fatigue, revisions of D 1598 and D 1599 to make them suitable for both thermoset and thermoplastic pipe, and specifications for other thread systems, fittings, joints, and pressure ratings.

Sectional Committee B16 Subcommittee 12 on Plastic Pipe Fittings, Flanges and Valves in the American Standards Association has work underway on specifications for fittings. This work is being coordinated with that in SPI and ASTM. ASA Sectional Committee B72 on Plastic Pipe is reviewing the Commercial Standards and ASTM specifications for plastic pipe. ASA Sectional Committee B31 has established a study Group on Plastic Pipe Stresses which will study the tentative method for estimating long-term strength and working stresses developed in the SPI and ASTM as part of their activity.

The United States has been accepted as a participating member of Subcommittee 6 on Pipes and Fittings of Plastic Materials for the Transport of Fluids of Technical Committee 5 of the International Standards Organization (known as ISO/TC5/SC6). The American Standards Association, which represents the United States in the ISO, is presently considering means to handle this work. One suggestion has been that a National Committee for ISO/TC5/SC6 be established with representation from the three ASA Sectional Committees, SPI, SPE, and ASTM Committee D-20.

Some of the other organizations interested in standards for plastic pipe and fittings are the American Gas Association, American Petroleum Institute, American Society of Corrosion Engineers, American Water Works Association, American Society of Mechanical Engineers, Manufacturers' Standardization Society of the Valve and Fittings Industry, and American Welding Society.

The Federal Specifications for plastic pipe and fittings are as follows:

SS-P-358A Pipe, Bituminized Fiber, "Perforated Drainage" and Fittings for same, (24 Feb. 60).

SS-P-356 Pipe, Bituminized-Fiber, Sewer, and Fittings for same, (6 Apr. 55).

L-P-540 Plastic Tubes and Tubing, Heavy Walled, Polyvinyl Chloride, Rigid, (21 Jan. 59).

The Military Specifications for plastic pipe and fittings are as follows:

MIL-P-22245 Pipe and Pipe Fittings, Thermosetting Reinforced Plastic, (30 Oct. 59).

MIL-P-22011 Pipe Fittings, Plastic, Rigid, Unplasticized, High Impact, Polyvinyl Chloride, (29 May 59).

MIL-P-14529(1) Pipe, Extruded, Thermoplastic, (5 May 58).

MIL-P-19119A(1) Pipe, Plastic, Rigid, Unplasticized, High Impact, Polyvinyl Chloride, (21 Feb. 58).

MIL-P-26692 Tubes and Tubings, Polyethylene, (12 Mar. 59).

MIL-P-22296 Plastic Tubes and Tubing, Polytetrafluoroethylene, "TFE Fluorocarbon Resin," Heavy Walled (7 Jan. 60).

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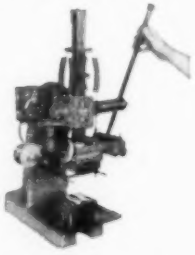

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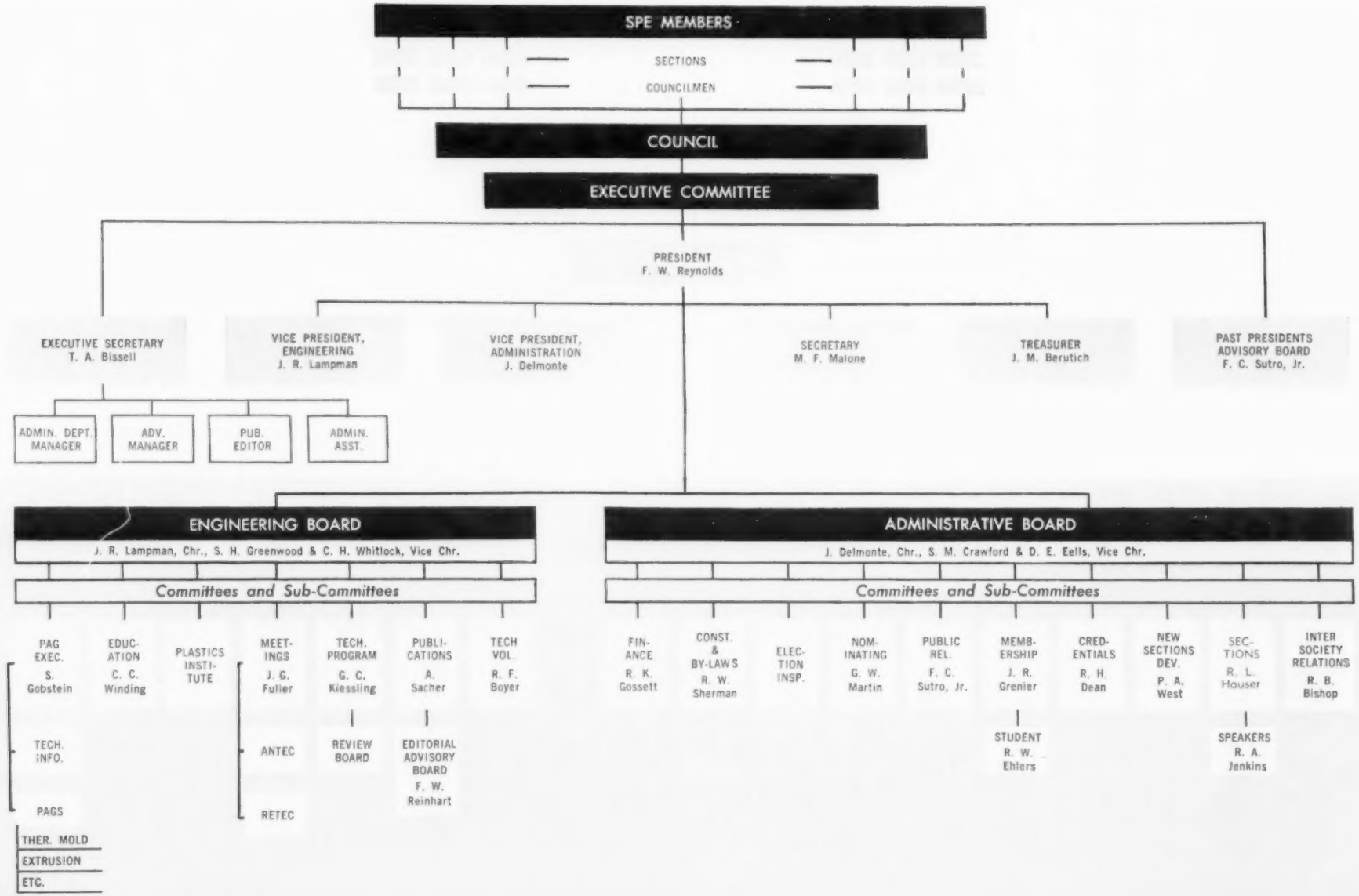

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Organization Chart Changes

Since this issue went to press, the following changes to the organization chart on page 161, this issue, have been made—

Technical Information Committee is now a standing Engineering Board committee. Chairman is A. Lightbody.
Intersociety Relations Committee has been made an Engineering Board committee.
Election Inspectors Committee has been made a sub-committee of the Nominating Committee.
P. D. Kelly replaces P. A. West as chairman of the New Sections Development Committee.
R. Hauser is chairman of the Sections Committee.

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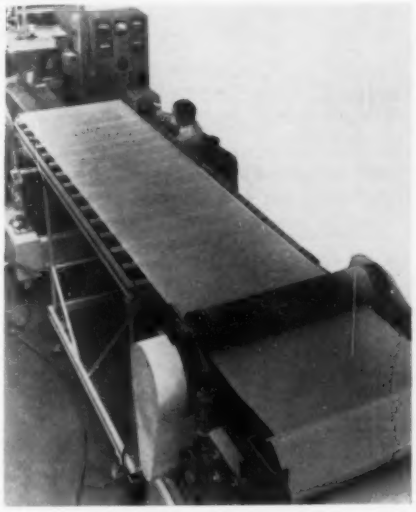
Extrusion of Sheet from High Density Polyolefins



Robert Doyle

Phillips Chemical Company

How to equip, start up and run a sheet extrusion operation, with a chart of solutions to the most common operating difficulties

In the past four years, Phillips Chemical Company's Sales Service Laboratory has extruded nearly one-half million pounds of sheet from high density polyethylene and ethylene copolymer resins. The following extruding instructions and "Operating Guide" represent a condensed summary of that experience.

Resins

Sheet may be extruded from these resins over a wide range of melt indexes but only those near the lower limit of good sheet extrusion characteristics are generally selected. With 0.96 density ethylene homopolymer and 0.95 density ethylene-butene copolymer resins, nominal melt indexes in the range of 0.2 to 0.3 are recommended. Sheet produced from higher M.I. resins may exhibit a high gloss but excessive sag and other problems will be encountered in subsequent thermoforming operations. In addition to optimum forming properties, low M.I. sheet also provides maximum toughness plus the best resistance to environmental stress cracking (ESC) at any particular density. In applications where ESC resistance is the major consideration, the 0.95 density ethylene-butene copolymer should be chosen. Otherwise, the 0.96 density ethylene homopolymer is selected because it provides the maximum stiffness for any ethylene-based resin, thereby permitting the use of the lightest, most economical thicknesses.

Equipment

High density polyolefins may be extruded into sheet (0.030" to 0.250" thick) with basically the same equipment which has been employed for high impact styrene sheet. However, some additions or changes may be required. The modifications needed in any current or prospective sheet line may be determined by a comparison with the following list of equipment recommended for 0.96 density polyethylene, 0.95 density ethylene-butene copolymers, and closely related resins:

Extruder—Length/diameter ratio of 20:1 or more with ample horsepower for size and speed. Screw should be of deep channeled, constant pitch, metering type with short (5 turns or less) compression section. Compression ratio should be between 3:1 and 4:1.

Sheet Die—A quality, high impact styrene die such as shown in *Figure 1* is very satisfactory. Land length of 2¼" or more is preferred although generally this factor does not appear to be critical.

Three-Roll Polishing Stack—These highly polished, chrome plated rolls should be at least 8" in diameter, larger for high production rates, and designed internally for close temperature control.

Temperature Control Units—One unit required for each of the above three polishing rolls. All three should be capable of circulating high volume of liquid through rolls at temperatures up to 255°F. Hence, for use with water, pressurized systems are an absolute necessity.

Cooling Conveyor—Inserted between the polishing roll unit and rubber pull-roll unit, this conveyor permits the sheet to lie flat during final cooling. It should be more than 10 feet long and/or provided with means for forced cooling action (air blowers, water spray cooling, etc.) Equipment built with both the polishing rolls and the rubber pull-rolls on one integral unit, usually with a 5-foot conveyor between, will be severely limited as to output.

Rubber Pull-Rolls—Both of the pull-rolls should be rubber-covered for good traction and this unit should be capable of being operated at from 20% faster to 10% slower than the polishing roll unit, in terms of relative surface speeds.

Shear—Usually a metal-cutting shear rated for at least 14-gauge steel is provided.

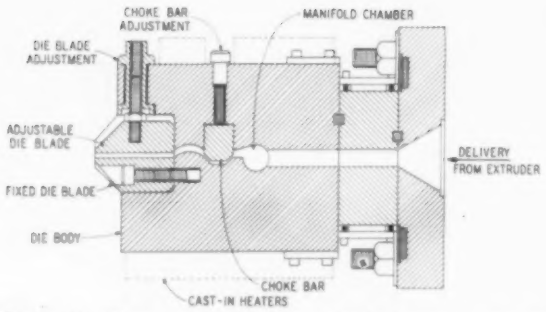


Figure 1. Sheet extrusion die, high impact styrene type, showing choke bar important for controlling heavier gauges

Stacker—A wide variety of ingenious units are available for stacking the sheet as it comes from the shear.

In addition, continuous automatic thickness indicating and recording equipment should be given serious consideration for the ultimate in quality control and production efficiency.

Photo on page 165 shows a high density PE sheet train in operation at our Sales Service Laboratory. Using a 2½" extruder and a 40" wide die, the equipment shown has produced sheet at rates up to 125 lbs./hr. The operating data given in *Table 1* was obtained with this set-up. On production-scale equipment, production rates will be equivalent to those for any other thermoplastic sheet materials if a properly designed screw and adequate downstream cooling capacity have been provided. Laboratory work has demonstrated the vital importance of correct screw design.

Start-Up Procedure

In starting the sheet train, the flow across the die should be balanced out before moving the polishing roll unit into place. Allowing the extrudate to fall to the floor, the choke bar (see *Figure 1*) should be adjusted from an initial maximum opening until a china crayon line drawn on the sheet at the die lips remains parallel to the lips for at least 4 to 6 inches of travel as it falls. Thereafter, this crayon line may curve out to a gentle, uniform arc, traveling faster at the center than at the edges; but no irregularities should appear in the line. Then the polishing roll unit may be moved into position, accurately parallel with and as close to the die lips as possible. In addition, this unit must be leveled so that the sheet enters the nip between the first two rolls without contacting either roll surface before the nip, at least for all thicknesses below 150 mils (0.150"). For heavier sheet at slow speeds, it may not be possible to completely avoid contact with the lower roll just before the nip because of the droop of the sheet between the die and the rolls.

Caution: Under no circumstances should the sheet be calendered in the nip of the first two rolls. If a bank (roll of molten plastic) builds up behind this nip, the resultant sheet may exhibit "chevron marks". As indicated in the Operating Guide and *Table 2*, the opening between these two rolls should be set at the desired nominal gauge with the operating speeds adjusted thereafter to give very little if any bank. Pneumatically or hydraulically loading the mounting arms from one of these polishing rolls against adjustable stops will permit an accurate setting of the nip opening.

Finally, the sheet is threaded through the entire train to the pull-rolls. While we thread the sheet "up-the-stack" in our polishing rolls (see *photo on page 165 and Figure 2*) because of the relative heights of our units, we do not consider this to be a requirement for good operation. Either "up-the-stack" or "down-the-stack" threading may be employed with equal success, provided only that proper operating conditions are used.

Quality Check Points

Gauge (thickness) uniformity across the width and length of the sheet is extremely important for good surface appearance and best thermoforming characteristics. Any difficulties with non-uniform heating or sag in any one sheet during the forming operation can usually be traced directly back to poor gauge control at the extruder.

One visual indication of gauge uniformity with unpigmented high density polyolefin sheet during extrusion is the shadow pattern behind the sheet where it wraps partly around the middle roll in any 3-roll stack. As shown in *Figure 2*, this dark shadow (where the sheet achieves optical contact with the roll) should have a straight edge across almost the entire width, tapering off possibly just a

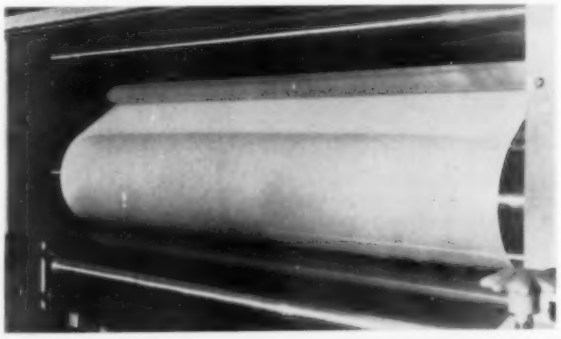


Figure 2. View from beneath conveyor. Note uniform shadow pattern behind sheet on middle roll

Table 1. Typical Physical Properties of Sheet Extruded as Described in this Article

Property	ASTM or Other Test Method	POLYOLEFIN RESIN TYPE*						
		6002			5003		TR-101 (Black)	
Nominal Gauge (mils)		60	125	187	60	125	60	125
Light Transmission (%)	Welch "Densichron"	55	38	25	61	41	—	—
Tensile Strength (psi)	638-58T							
Machine Direction		4470	4480	4260	3960	4140	2000	1850
Transverse Direction		4480	4420	4290	4060	4110	1750	1860
Elongation (%)	638-58T							
Machine Direction		30	30	35	45	35	420	250
Transverse Direction		20	25	30	40	35	630	430
Brittleness Temperature (°F)	D746-57T	<−180	<−180	<−180	<−180	<−180	−93	−93
Vicat Softening Point (°F)	D1525-58T	260	260	260	255	255	240	240

* MARLEX 6002 is a 0.960 density polyethylene homopolymer with a Melt Index (M.I.) of 0.2.
* MARLEX 5003 is a 0.950 density ethylene-butene copolymer with a M.I. of 0.3.
MARLEX TR-101 is a 0.950 density "Tailored Resin" with a M.I. of 0.3.
MARLEX is a trademark for Phillips' family of olefin polymers.

OPERATING GUIDE

Problem	Possible Causes	Suggested Solutions
I. DULL TO ROUGH SURFACE OR SURFACE AREAS	A. NON-UNIFORM GAUGE (THICKNESS) DUE TO IMPROPER DIE ADJUSTMENT AND/OR TEMPERATURES	1. Adjust die to give maximum variation of ±2 mils for 20 to 100 mil sheet, ±2% for sheet over 100 mils thick. 2. Adjust heaters to give uniform melt temperature across die. Note: End plate heaters may be needed to maintain temperatures near ends of die. 3. Check for malfunctioning die heaters, thermocouples and controllers. Check calibration of controllers. Correct as necessary.
	B. COLD POLISHING ROLLS. (see Figure 3)	1. Raise roll temperatures into 200°-255°F range. **Table 2** provides a guide for specific rolls for different sheet thicknesses.
	C. EXCESSIVE OPENING IN NIP BETWEEN FIRST TWO ROLLS WHICH SHEET CONTACTS	1. Reduce opening to desired nominal gauge and adjust line speed accordingly.
	D. SURGING	1. Cool hopper zone with water (or air, if so equipped) to prevent bridging. 2. Balance extruder temperatures (Ref. **Table 2.**) Front zone should be set same as center of die with other zones decreasing in 10° to 20°F steps back toward hopper. If surging persists, raise cylinder about 50°F at front zone to 60°F higher at other zones. If not then corrected, return to preceding recommendations and seek other sources of difficulty. 3. Check for malfunctioning cylinder heaters, thermocouples and controllers. Check calibration of controllers. Correct if needed and then rerun as in "2". 4. Check for variations in line speed, extruder drive (slipping belts, electrical fluctuations, etc.) and correct if required. 5. If using reground scrap, check for excessively large particles or fines and remove by screening if present.
	E. POLISHING ROLL(S) OUT-OF-ROUND	1. Dial indicate and true up or replace if necessary. Note: Only one area of roll may be egg-shaped so full width should be checked.
II. IRREGULAR EDGES (VARYING WIDTH).	A. SURGING	1. See I., D., 1 through 5.
III. CURL (LACK OF FLATNESS)	A. INCORRECT ROLL TEMPERATURES	1. Starting with conditions suggested in **Table 2,** adjust temperatures of first two rolls to contact sheet so as to give maximum gloss. Then, adjust temperature of **last roll as follows: increase** if edges curl away from surface of this roll, **decrease** if edges curl in toward this roll. 2. Provide uniform (within ±2°F) temperatures across roll faces. High rate of flow of circulating medium is required. Pressurized water system generally preferred. Interior of rolls must be scale-free to avoid "hot spots", etc. (Check uniformity across roll with surface pyrometer.)
	B. INSUFFICIENT COOLING IN SHEET TRAIN	1. Use larger diameter polishing rolls—12" to 18" diameter for high production rates. 2. Use longer cooling conveyor to provide more cooling time before cut-off. 3. Install fans or fog spray chamber for more rapid cooling along conveyor.
IV. LINES-MACHINE DIRECTION (see Figure 4)	A. CHARRED RESIN ON OUTER EDGES OF DIE LIPS	1. Scrap off die lips from outside with brass or other "soft" metal tools.
	B. SCRATCHED, BURRED OR DIRTY DIE BLADES AND/OR DIE	1. Remove die blades and clean, honing out any burrs or scratches. 2. If same lines persists, clean and polish channels in die body.
	C. SCORED POLISH ROLL(S)	1. Polish out scratches or resurface if required.
V. LINES OR BANDS—TRANSVERSE OR DIAGONAL DIRECTIONS	A. ROLLING BANK IN THE NIP BETWEEN THE FIRST TWO ROLLS	1. Increase line speed somewhat if bank extends almost full width of sheet. 2. If bank is localized, close down die blade or choke bar in indicated areas.
	B. SHEET STICKING TO POLISHING ROLLS	1. Reduce roll temperatures. 2. If a dull surface results from step No. 1, lower stock temperature so that roll temperatures can again be increased. Then, balance out roll temperatures vs stock temperature to regain surface gloss without sticking.
	C. INCORRECT STOCK TEMPERATURE	1. Correct as indicated. Either extremely low, e.g. 320°F, or high temperatures (just short of sticking to polishing rolls) may yield wavy lines in the transverse direction.
	D. JERKY OR OTHER NON-UNIFORM OPERATION OF SHEET TRAIN	1. Provide for constant, uniform take-off speeds.

TEAR OUT ON THIS LINE

OPERATING GUIDE

Problem	*Possible Causes*	*Suggested Solutions*
VI. **FOREIGN, COLORED MATERIAL IN SHEET**	A. CONTAMINATION OF RESIN	1. Inspect bags, hopper loader and/or drier if used, and hopper on extruder. Take indicated steps to eliminate sources of foreign matter. 2. Use air hose and/or clean rags to completely clean above equipment during color changes.
	B. DECOMPOSED (BROWN OR BLACK) PARTICLES	1. Clean die and extruder of **any** other plastic materials before starting to run high density polyolefins. 2. Follow rigid procedure of always starting up as soon as screw can be turned over safely and of always cooling extruder and die down to 325°F or less **before** stopping screw for extended periods, (with continued forced cooling thereafter). 3. Remove and clean extruder screw periodically. 4. Eliminate zones of stagnation in die. 5. Check for scoring of screw or cylinder liner and for cracks in liner and take remedial steps if required.
	C. INSUFFICIENT PURGING	1. Provide bleed plugs at ends of manifold chamber of die to reduce purge time and amount of scrap. 2. Purge, with bleeds, for full time needed to complete clean-out. 3. Disassemble and clean entire die periodically, more frequently when running a variety of different colors and melt indexes.
VII. **POOR COLOR DISPERSION**	A. IMPROPER SELECTION OF FEED MATERIAL FOR APPLICATION	1. Use precompounded resin for optimum color dispersion, i.e., whenever dispersion is critical and/or sheet is to be extruded or formed to light gauges and/or pigments used are difficult to disperse. 2. Use dry color blends only for heavy gauges and/or easily dispersible pigments and/or less critical applications. 3. Use masterbatch blends to meet intermediate requirements. 4. When making in-plant blends, pigments with sufficient heat stability to withstand extrusion temperatures must be selected.
VIII. **POCK MARKS OR PITS** (see Figure 5)	A. MOISTURE (POLYOLEFINS ALONE DO NOT PICK UP MOISTURE BUT SOME ADDITIVES SUCH AS CARBON BLACK WILL CAUSE THE COMPOUNDS TO PICK UP MOISTURE ON THE SURFACE OF THE PELLETS, EVEN WITH ONLY A BRIEF EXPOSURE TO HUMID AIR. AFTER EXTREME EXPOSURE, MOISTURE MAY NOT BE READILY REMOVABLE.)	1. Protect bags in storage from water seepage. 2. Bring bags in from cold storage area at least 24 hours prior to extrusion to avoid problems with moisture condensation. 3. Dry resin in hopper dryer or oven or with vented extruder if available. (Note: High softening point of high density polyolefins permits the use of higher than usual drying temperatures—up to 250°F air from dryer). Provide **at least** ½ hour capacity in hopper at minimum of 200°F for removing normal surface pick-up with blacks, more time and or heat for wetter compounds.
IX. **PLATING OUT OF WHITE DEPOSITION ON POLISHING ROLLS.**	A. EXCESSIVE ROLL TEMPERATURES	1. Lower roll temperatures, following suggestions given in III., A., 1 and 2 along with V., B., 1 and 2.
	B. EXCESSIVE STOCK TEMPERATURES	1. Reduce all temperature settings on extruder and die. Note: see **Table 2.** If overheating persists and all heaters, thermocouples and controllers check out correctly, refer to Sect. X below.
X. **STOCK (MELT) TEMPERATURE BUILD-UP**	A. INSUFFICIENT REMOVAL OF EXCESS HEAT GENERATED IN CYLINDER	1. Utilize best cooling capacity available on extruder. Liquid cooling systems are more effective than the air systems which have been supplied on older machines.
	B. IMPROPER SCREW DESIGN	1. Replace Dulmage or similar mixing (compounding) type screws with deep channel, nylon-type screw or another deep channel, metering type screw having **no more than** 5 turns of compression section, i.e., where channel depth decreases uniformly. 2. Cut down so-called polyethylene screw to design indicated above or replace with proper screw. 3. If a suitable screw cannot be made available, then slow down entire line and extruder to reduce frictional heat developed in cylinder. Note: Water cooling of screw is poor practice as this will usually put a narrow stripe down the center of the sheet, trailing off tip of screw, or lead to other problems because of the material frozen onto the screw.

Additional copies of this Operating Guide are available from SPE Journal.

Table 2. Typical Extrusion Conditions Recommended in Operating Guide

Polyolefin Resin Type*	6002			5003		TR-101 (Black)	
Nominal Gauge (mils)	60	125	187	60	125	60	125
Screw Speed (rpm)	93	93	93	93	93	93	93
Cylinder Temp. (°F) Zone 1	370	370	370	370	370	330	330
2	380	380	380	380	380	340	340
3	390	390	390	390	390	350	350
4	400	400	400	400	400	360	360
Gate Temperature (°F)	400	400	400	400	400	360	360
Gate Pressure (psi)	1000	1000	1000	1000	1000	1200	1200
Die Temperature (°F) (All zones)	400	400	400	400	400	360	360
Initial—Die Opening (mils)	250	250	250	250	250	200	200
Polishing Roll Temperatures (°F)**							
Bottom	230	230	230	230	230	224	230
Middle	240	245	245	240	240	238	242
Top	225	230	230	220	220	227	227
Polishing Roll Opening (mils)	60	125	187	60	125	60	125

* For explanation, see Table 1.
** These are for "up-the-stack" operation as described in article. Temperatures given are liquid temperatures. Surface temperatures are about 15°F lower before sheet is threaded through the roll stack.

little close to the edges. If the sheet does not strip uniformly and parallel to the roll axes in this manner as it is transferred to the last roll in the stack, then it is apparent that the gauge is not satisfactory. An irregular demarcation between dark and light areas along this stripping line is proof that the die needs to be adjusted. For this reason, it is often best to line out with "natural" (unpigmented) resin before starting to feed any pigmented compounds to the extruder—although some slight further adjustments may still be required due to differences in flow resulting from the pigmentation.

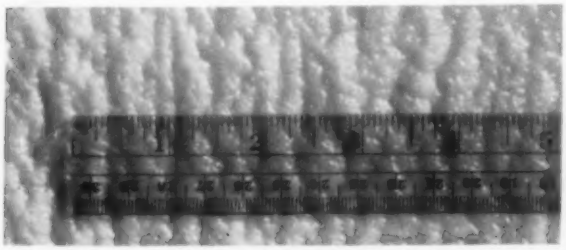


Figure 3. Rough surface caused by cold finishing rolls

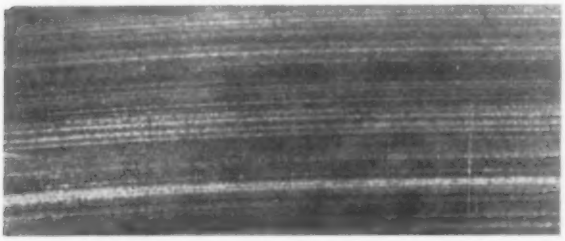


Figure 4. Die lines on sheet surface in machine direction may be due to charred resin on die blades or to imperfections in die blades or polishing rolls

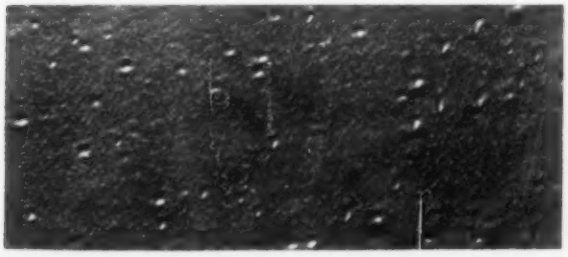


Figure 5. Pock marks due to moisture picked up by additives

It is common practice to make most of the gauge adjustment with the choke bar for heavier gauges (over about 60 mils), using the adjustable die blade to a much greater extent only for the lighter gauges. It is also very practical to operate with only two die blade settings: a 250-mil setting for any sheet down to 100 mils thick, a 125-mil setting for any lighter gauges.

Scrap which has been kept scrupulously clean and chopped to about the same size as the original pellets may be blended back with virgin material to feed the extruder. **Caution**: Significant quantities of reworked scrap will decrease the sag of the sheet during thermoforming. For this reason, the scrap fed back to the machine should be held to a constant amount for uniform sheet quality. Also, for extremely critical, deep-draw thermoforming, the sheet should contain little or no scrap. In such cases, the scrap may be saved for sheet which is to be formed into large area, shallow items where the reduced sag will be a real advantage.

Laboratory results indicate that sag during thermoforming may also be reduced by using the maximum die opening and highest stock (melt) temperature which are practical, consistent with good quality sheet. However, the effect is not nearly so pronounced as when scrap is blended back into the hopper feed. In any event, once a satisfactory sheet quality has been determined, the per cent scrap should be rigidly maintained and all operating conditions should be carefully reproduced on subsequent runs according to complete and detailed production records. An hourly recording of all conditions is recommended.

Some typical physical properties for sheet produced as described in this article are given in *Table 1*.

Use of Guide

For further assistance in answering questions which may arise once operations are underway the "Operating Guide" *(page 167 and 168)* has been prepared. While it is obviously impractical to cover all possible contingencies, every effort has been made to make this guide as helpful as possible. Nevertheless, it must be considered as just that, i.e., a guide only. In using this guide, it should be kept in mind that only one change should be made at a time—and the result determined—unless it is very apparent that more than one factor is in error. In addition, the "Possible Causes" and "Suggested Solutions" should each be taken in the order listed—again, unless it is obvious which factor should be corrected. The first eight "Problems" listed are all related to the appearance of the sheet while the last two are concerned with problems which may be observed during operation but which do not readily lend themselves to classification under any one of the other headings.

Toluene Diisocyanate 2, 6- Isomer — Its Effect on Urethane Polymers

S. Edmund Berger, Frank L. Cataldo, Frank J. Dwyer and Herman Stone

Research and Development Department, Allied Chemical Corporation, National Aniline Division

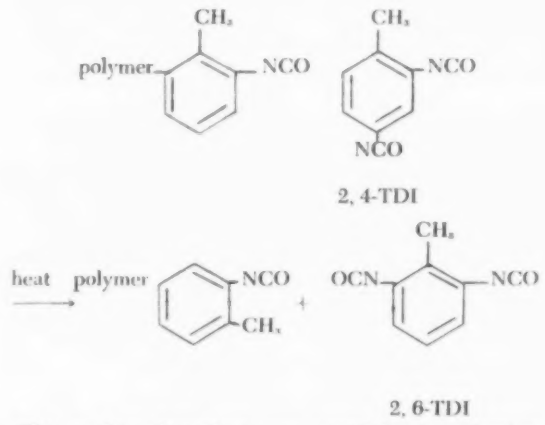
- *Urethane polymers based on 2,6-TDI show greater linearity than those based on 2,4-TDI*
- *Ultimate polymer properties are affected by time of gelation*
- *Higher gelation rates of urethane foams caused by increased 2,6-TDI levels and no postheating*
- *Postheating does not increase 2,6-TDI content*

One of the methods for preparing urethane prepolymers involves the reaction of essentially stoichiometric amounts of toluene diisocyanate (TDI) and a polyol at 100-120°C to a predetermined viscosity followed by the addition of additional TDI. The heating of the mixture is then continued for varying periods of time (post-heating) in order to establish a certain number of additional branch points along the polymer chain.

Both the foaming process and fundamental foam properties are affected by this postheating step. Repeated observations made in our laboratories in the course of earlier investigations indicate that, contrary to expectations, the gelling of postheated, more highly branched prepolymers during the foaming process occurs at a slower rate than that of the non-postheated prepolymers. It appeared that the observed gelling behavior of the prepolymers could be due to a reduction in their overall reactivity caused either by an actual, heat-induced chemical reaction, or by some other mechanism.

The kinetic relationships between the various isomeric toluene diisocyanates are well established (*1, 2*).

To explain the decrease in gelation rate of postheated prepolymers, it was postulated that thermal treatment of a prepolymer could induce in its free toluene diisocyanate portion an increase in the less reactive 2,6-isomer. This could occur by an exchange reaction involving the polymer molecule and the free toluene diisocyanate according to the following scheme:



This working hypothesis was tested by investigating a number of prepolymers varying only in the relative proportions of 2,4-TDI and 2,6-TDI. A prepolymer based on m-phenylene diisocyanate was also included in this study, in order to isolate effects due to steric hindrance of the methyl group alone.

As discussed below, the results obtained definitely disproved this hypothesis. Hence, it appears that the reactivity in the foaming system under study is controlled by a different mechanism.

Experimental

The prepolymers were prepared by heating the polyol mixture and the diisocyanate (NCO/OH = 1.05) at ap-

proximately 110°C to a viscosity of 18,000-22,000 cps. at 25°C, and then diluting to approximately 10% free NCO with additional diisocyanate. In one series of experiments, the prepolymers were then cooled, while in another they were postheated for an additional hour before cooling. A final standardization to 10.5% free NCO was made in both series before foaming. Pertinent data are summarized in *Tables 1 and 2*.

Table 1. Prepolymers from a Mixture of Polyether Diol and Triol and Various Diisocyanates (non-postheated)

% 2, 6-TDI in Toluene Diisocyanate	63	54	35	20	0	m-Phenylene Diisocyanate (1)
REACTION TIME, min. (time at 110° C to desired viscosity)	195	not studied	214	202	221	165
VISCOSITY, before dilution, poises at 25° C	210	not studied	210	220	195	215
VISCOSITY, after dilution, poises at 25° C	156	not studied	96	96.4	82.4	87.6

(1) Reaction temperature was 80–90° C.

Table 2. Prepolymers from a Mixture of Polyether diol and triol and Various Diisocyanates (postheated—60 min.)

% 2, 6-TDI in Toluene Diisocyanate	63	54	35	20	0	m-Phenylene Diisocyanate
REACTION TIME, min. (time at 110° C to desired viscosity)	115	130	138	150	164	not studied
VISCOSITY, before dilution, poises at 25° C	180	180	185	182	230	not studied
VISCOSITY, after dilution, poises at 25° C	182	110	136	112	125	not studied

The acidity of the diisocyanate was adjusted slightly in all cases to provide adequate control of reaction rates. More substantial adjustments were required for the highly reactive m-phenylene diisocyanate.

Earlier work had shown that differences in viscosity of the magnitude shown above, at any one isomer ratio, did not affect foam properties significantly. For this reason and in view of the fact that the % NCO (before standardization) does not vary appreciably with isomer ratio, it was assumed that prepolymers of the same viscosity containing varying amounts of 2,6-TDI have molecular weights of the same order of magnitude.

Foams were prepared on a Klauder-Williams machine delivering 1700 g./minute. The following activator solution was used (g./100 g. of prepolymer containing 0.5 g. Dow Corning* 200 Fluid (50 cs.)):

2.6 water
0.3 triethylamine
1.5 N-methylmorpholine

The rate of exotherm, the maximum exotherm and the temperature at the time of gelation were determined during the foaming process by means of thermocouples inserted into the molds. A multipoint recorder was used to record the temperatures. Pertinent data are collected in *Table 3*.

Gel time is the time, after start of pour, beyond which rising foam, if mechanically disturbed, does not continue to flow in the area of disruption.

* Dow Corning Corporation.

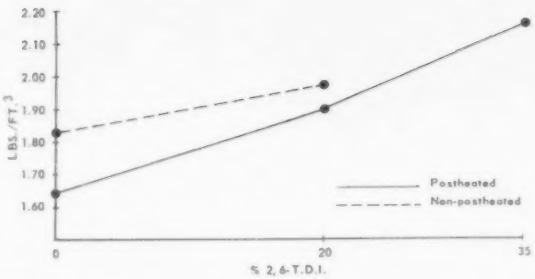


Figure 1. Wide range of foam densities exist

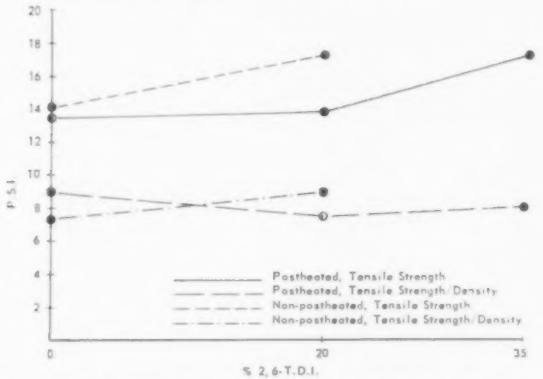


Figure 2. Graphs show an apparent effect of 2, 6-TDI content or postheating time on tensile strength which disappears on assumption of a linear relationship with density.

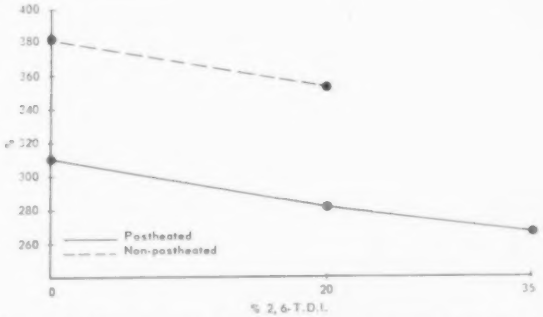


Figure 3. Elongation decreases with increasing 2, 6-TDI content.

The foams were precured for 20 minutes in an oven at 80°C, then crushed, cured at 120°C for 3 hours and recrushed. Foam properties were determined (according to ASTM Methods).

Trends in Physical Properties

Foam density, tensile strength, and compression load (loadbearing capacity) decreased with decreasing 2,6-TDI content of the polymers, while there was an increase in compression sets, elongation number of closed cells and tendency toward shrinkage (*Figure 1-7*). These trends were somewhat less pronounced in foams based on postheated prepolymers. Similar trends were also noticed for postheated vs untreated prepolymers at any one level of 2,6-TDI content. Somewhat similar trends in polyester foams have been observed previously (4).

As shown in *Figure 1*, there is a wide range of foam density. To reduce the apparent effect of density on those

Table 3. Foaming Characteristics of Prepolymers

2, 6-TDI content of diisocyanate used	Gel time,[1] seconds	Temp. at Gel time, °C	Maximum Exotherm °C
63	<70[2]	<50	67
54	--	--	--
35	75[2]	43	66
20	110	53	78
0	220	71	81
	Postheating time: 1 hour at 110° C		
63	<70[2]	<50	71
54	75[2]	46	72
35	100	51	80
20	160	60	80
0	275	74	82

(1) Measured from the instant the filling of the foam pan is started to the time definite gelation has set in.

(2) Foam collapsed after start of gelation.

physical properties which normally are greatly affected by density, i.e., tensile strength and compression load, the ratio of these parameters to density has also been plotted (*Figures 2, 4, 5*). From *Figure 2*, it can be seen that there is an apparent effect of 2,6-TDI content or postheating time on tensile strength which disappears on assumption of a linear relationship with density. Presumably the observed trend is therefore only a reflection of the variation in density. On the other hand, compression load (*Figure 4, 5*) is almost independent of the effect of density, and the observed variations are therefore real effects of polymer structure.

As indicated in *Table 3*, varying the 2,6-TDI content or the extent of postheating causes large differences in the time and temperature at which gelation starts. The maximum exotherm and the rate at which this maximum value is attained are, however, not affected. All of these relationships are shown in *Figures 8, 9 and 10*. *Figure 8* for comparison contains data pertaining to the prepolymer based on m-phenylene diisocyanate. The latter shows a higher exotherm and a more rapid attainment of the maximum exotherm.

Definite correlations were found to exist between foaming characteristics (gel time and temperature) and the physical properties of the foam. For example, the density of foams in the systems studied is exclusively determined by the time of gelation. As illustrated by a comparison of *Figures 1 and 8*, the order in which density decreases is the same as the order in which gel time increases and is independent of composition and postheating cycle. This also shows that only the fraction of CO_2 evolved before the start of gelation contributes to the lowering of foam density. In general, regardless of whether a particular gelation time has been attained by postheating or by adjustment of the 2,6-TDI content, the effects on the physical properties of the resulting foams can be correlated with gelation time.

It appears, therefore, that the change in foam properties can be related to the degree of imbalance between the reactions leading to gelation (formation of ureas, biurets, allophanates and isocyanate dimerization and trimerization) and the foaming reaction (CO_2 evolution). If this imbalance becomes too pronounced, foam collapse will occur. This collapse can be avoided by suitable adjustment of the catalyst if the imbalance is not too great—but in this study we maintained the catalyst ratios found to be optimum for Nacconate 80.

Furthermore, it was established, as shown in *Figure 8*, that the changes in gel time are independent of the total foaming time and of the maximum exotherm. The time required to reach maximum exotherm and maximum temperature were the same within experimental error for all stable

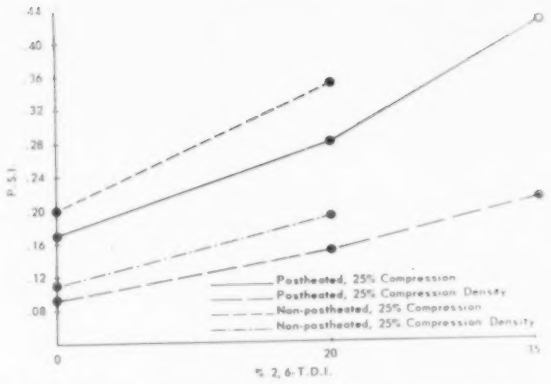


Figure 4. Compression load at 25% compression

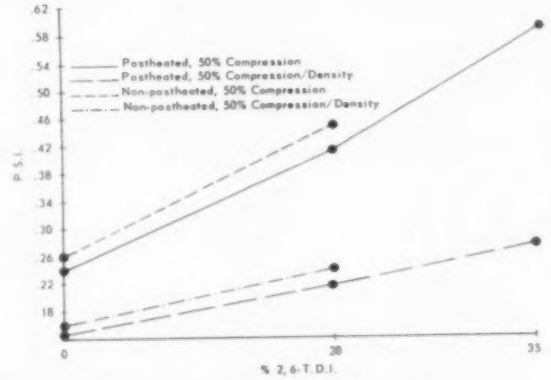


Figure 5. Compression load at 50% compression

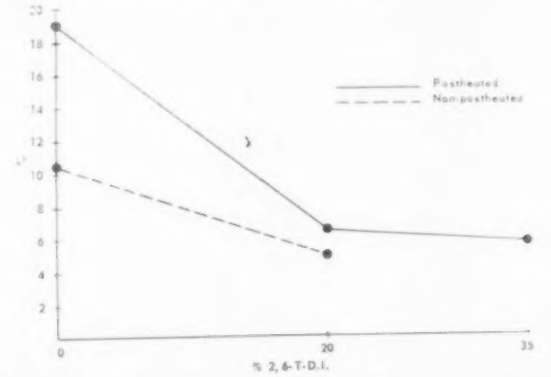


Figure 6. 90% compression set—6 hours at 158°F

foams based on toluene diisocyanate. The total amount of heat liberated in each case should be approximately the same since the same number of NCO groups are reacting. Any difference in temperature would be due to heat losses during the reaction, which are expected to be relatively small since the foam produced is a good insulator.

This difference in heat loss can be found in cases where the reaction rate is greatly different from that of the standard system. In the sterically unhindered m-phenylene diisocyanate system, where the number of reacting -NCO groups is the same as in the TDI system, but the reaction rate is much higher, the significantly higher exotherm is mainly a result of relatively slower heat dissipation. These observations support the conclusion that in all the toluene

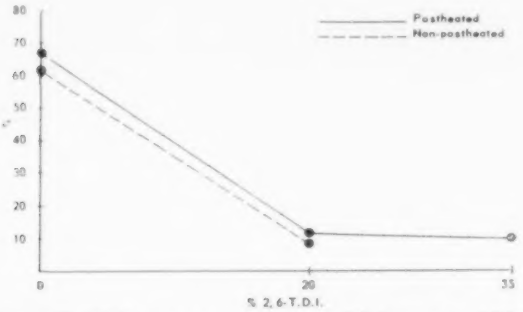


Figure 7. 90% compression set—22 hours at 158°F

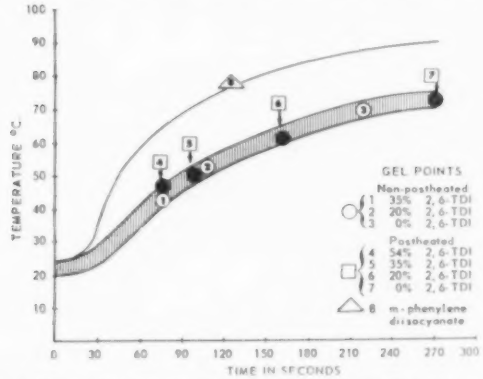


Figure 8. Exotherm curve—effect of postheating and 2,6-TDI content on gel time & gel temperature

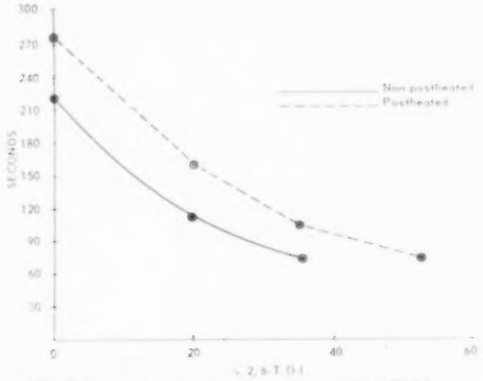


Figure 9. Effect of postheating and 2,6-TDI content on gel time and gel temperature

diisocyanate cases discussed, the duration of the over-all reaction was approximately the same and that the observed differences in foam properties are due almost solely to differences in gel time.

In general, the same correlations between gelation, gas evolution and foam properties hold in one-shot polyether foam formulations, as shown by some preliminary work based on toluene diisocyanates varying in isomer ratio.

Conclusion

To be valid, a mechanism explaining the observed phenomena should account for delayed gelation caused by either a decreasing 2,6-TDI content or by increased branching induced by postheating. The fact that faster foam gelation occurs with prepolymers having a higher 2,6-TDI content definitely disproves the initial hypothesis that postheating causes an enrichment in the less reactive 2,6-TDI.

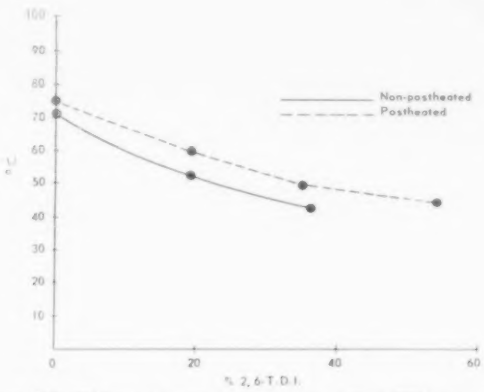


Figure 10. Effect of postheating and 2,6-TDI content on gel temperature

On the other hand, there seems to be no obvious reason why the major reactions leading to foam gelation should, at gelation temperatures of 45-55°C, greatly favor 2,6-TDI over 2,4-TDI.

It is possible that the higher rates of gelation caused by increased 2,6-TDI levels or by the elimination of postheating, are associated in both cases with more nearly linear polyurethane molecules leading to more rapid gelation by virtue of greater steric availability of the reactive sites along the polymer chain.

Some support for this hypothesis is found in the fact that atomic models of polymer molecules based on 2,6-TDI show a greater degree of linearity than those based on 2,4-TDI. The solubility of the urea produced from di-n-butylamine and 2,6-TDI is markedly lower in toluene-isopropanol (1:10) than the corresponding urea from 2,4-TDI. This fact also supports the contention that molecules derived from 2,6-TDI are more symmetrical.

It is, therefore, possible that the 2,6-TDI systems are less sterically hindered and therefore show an increase in over-all chemical reactivity of the molecule. Since postheating tends to produce bulkier, more unsymmetrical molecules, these also may be sterically more inhibited in gel formation, in spite of a greater number of branch points.

An important corollary of the results of this study is the realization of the fact that ultimate polymer properties can be affected by influencing the time of gelation in relation to the duration of the over-all reaction. This can be accomplished by varying the amount and composition of the activator solution, the amount of emulsifier, the method of prepolymerization, the composition of the polyol, or the isomer ratio of toluene diisocyanate.

Literature References

1. Bailey, M. E., Kirss, V., and Spaunburgh, R. G., *Ind. Eng. Chem., 48*, 794 (1956).
2. Kogon, I. C., *J. Org. Chem., 24*, 438 (1959).
3. Cooper, W., Pearson, R. W., and Darke, S., *Ind. Chemist 46*, 121 (1960).
4. Gmitter, G. T., and Gruber, E. E., *SPE Journal*, Jan. 1957, 27.

Acknowledgment

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Plastisol Gelation — A New Instrument and Formulating Technique

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New instrument simulates production conditions in determining gel rates of plastisols, allows development of plastisols with predesigned performance characteristics

For many plastisol applications, changes in viscosity during the fusion cycle are an extremely important consideration. In rotational molding, hot dip coating, slush molding or vinyl foam applications, changes in the formulation to obtain desirable physical or economic properties can alter the temperature-viscosity characteristics of a plastisol to such a degree that the resultant vinyl article has imperfections which make it of little or no commercial value. If a potential plastisol user can be assured that a new formulation will perform in essentially the same manner as his current material, not only is the time and effort required for evaluation of a new material reduced to a minimum but also changes in machine conditions and production cycles are obviated.

The gel rate approach to formulation presupposes that two plastisols having essentially the same gel rate curves would perform equally well under the same production conditions. Subsequent investigation has shown that such is, indeed, the case. Specific customer problems were selected when it was indicated that gel rate of the plastisol was a critical factor. The gelation characteristics of a wet sample of current production plastisol (or formulation) were determined and reformulation undertaken to incorporate desirable physical properties without disturbing the basic viscosity-temperature relationship. With an understanding of the variation in gel rate with the formulating parameters, the time required to obtain an acceptable replacement was relatively short. Hence, this concept not only aids the customer but also makes technical assistance more effective and rapid.

The approach, in addition, is not limited to cases where production factors are already established. Selected samples or formulations for plastisols encompassing a range of gelation properties can be submitted to the potential user. Successive approximations will establish a representative performance curve for the particular operation. Once this property is determined, pertinent physical properties can then be incorporated into the formulation while maintaining the same gelation characteristics.

From an examination of existing methods for the determination of gel rate curves (1, 2), it was felt that these methods did not sufficiently approach the time cycles (heating rates) or were not representative of the shear rates normally encountered in end-use. In addition, curves obtained over abnormally long time intervals were too closely grouped to define significant differences in gelation characteristics inherent in the various plasticizers. A new testing apparatus was developed, therefore, in an effort to overcome the above objections.

In cooperation with personnel of the Mellon Institute Department of Instrumentation and the Union Carbide Plastics Company, an instrument has been developed which simulates, to a marked degree, the conditions of production. The curves obtained by this method are sensitive to small changes in formulation parameters and the time to gelation (about fifteen minutes) is a reasonable representation of operating cycles. This particular time cycle represents a heating rate of approximately 10°F/minute and was chosen for convenience in laboratory testing. The heating rate can be doubled without significantly altering the shape and position of a given curve.

Description of Instrument

The apparatus, in its simplest form, consists of a circular aluminum cup attached to constant speed motor and surrounded by radiant heaters. A ⅛-inch stainless steel probe, equipped with a thermocouple, is centered, at a fixed depth, in the one-inch annular path of the sample cup. The probe, itself, is rigidly connected to a brass moment arm containing four strain gages. The deflection of the moment arm as a pressure is exerted against the probe by a plastisol in the rotating sample cup, is indicated quantitatively by the strain gage output. This voltage, as well as the thermocouple output, is recorded simultaneously on a low impedance, $X_1 - X_2$ recorder as a function of time. Resolution of these curves gives a temperature-viscosity function which is the gel-rate curve. A photograph of the apparatus is shown in *Figure 1*.

In operation, the apparatus is first standardized by applying a known dead weight to the moment arm. Using a calibrating circuit, a no-load and 100 inch-gram calibration are set on the recorder. Prior data had shown that a plastisol was no longer mobile at the viscosity represented by the upper limit of standardization. The sample cup is filled to a calibrated depth with the plastisol to be tested. This requires, in general, about 110 gms. of material. After mounting the sample cup within a baffle cup and the assembly set on the turntable, the probe is firmly positioned and the rotation of the sample cup about the fixed probe is begun. Although the rotational speed can be varied, 36 rpm is utilized in the standard procedure. The wattage applied to the radiant heaters controls the rate of heating the plastisol and can be varied with ease from 6.5 to 25°F temperature rise per minute. To facilitate the resolving of the time-temperature and time-torque curves, a rate of 9°F per minute is generally used in laboratory operations. As the plastisol is heated the plastisol viscosity drops to a minimum and there, as solvation increases, the viscosity increases and the plastisol gels.

In typical gel-rate curves, the abscissa is temperature in degrees Fahrenheit and the ordinate is torque measured in inch-grams. An approximate viscosity value can be obtained from the following relation:

$$\eta = \frac{2(4F + 9)}{3}$$

where

η = apparent viscosity in poises as determined on a Brookfield RVT viscometer, No. 4 spindle, 4 RPM, and

F = Torque in inch-grams.

It should be emphasized that the *relative shape and position* of the curve is the crux of the gel-rate approach, not any absolute value of viscosity which may be estimated from the curves.

The intercept of the curves on the ordinate is a function of the viscosity characteristics of the particular plasticizer-resin system. As heat is applied to the system, there is the expected decrease in viscosity due to the increase in temperature. As heating continues, solvation exerts its effect, overriding the normal viscosity decrease and the curve swings upward from its minimum as the plastisol begins to gel. As indicated by the slope of the curves, gelation may be gradual or rapid.

The final point for consideration is the temperature at which nonfluidity is attained. This has been arbitrarily defined as 100 inch-grams of torque. The temperature at this torque value will generally classify a plastisol as fast, intermediate or slow in gelling.

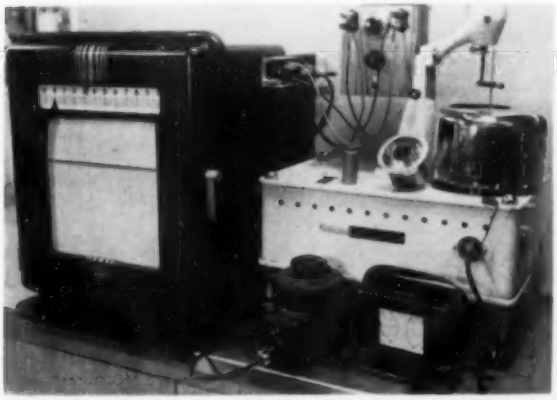

Figure 1. Apparatus for measuring gel rate as a function of temperature

The gel-rate data obtained by this method are reproducible within a range of ±1.5°F at any given torque value beyond the point of minimum viscosity. Variation of heating rates from 6°F per minute to 25°F per minute was found to have no significant effect on the shape and position of the gel rate curve beyond the minimum viscosity point. Results obtained at shear rates corresponding to rotational speeds of 25, 36 and 50 RPM were all within the limits of reproducibility of the instrument, indicating that gel rate determinations by this method are independent of small changes in shear rate. Aging of a plastisol over a period of fourteen days was found to have no effect on the gel side of the curve. The viscosity of the plastisol increases over the aging period, hence, the intercept on the ordinate (initial viscosity) increases. However, the curve for the aged plastisol meets the minimum near the point of upturn and follows the gel side of the curve to the point of nonfluidity.

Formulating Parameters—Using the Instrument

The use of the gel-rate technique as a formulating tool requires an understanding of the variation of gel-rate as a function of the normal formulating parameters. The following parameters will be discussed in detail: plasticizer choice, plasticizer blends, plasticizer concentration, resin choice, blending resin, filler addition, viscosity depressants and stabilizer.

Plasticizer Choice—*Figure 2* clearly indicates the variation in gel-rate curves as a function of plasticizer choice when resin and concentration are held constant. Curves A, B and C represent fast gelling plastisols. Such materials will have high initial viscosities (high initial torque), relatively high minima which will increase as the plastisol ages, and steep curves in the gel region. Curves D, E and F represent plastisols of intermediate gel rate. Initial viscosities and viscosity minima are low; curves are moderately

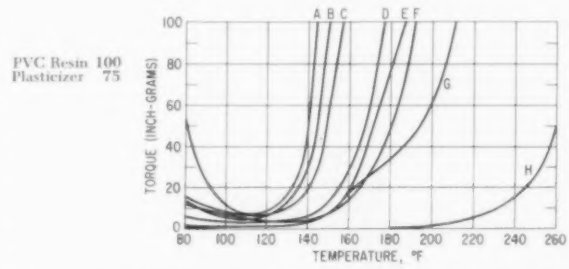

Figure 2. Variation of gel rate curves with plasticizer choice

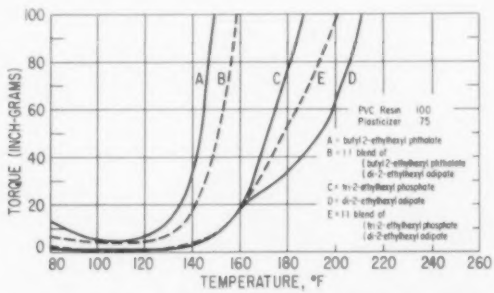

Figure 3. Effect of blending several plasticizers on gel rate curves

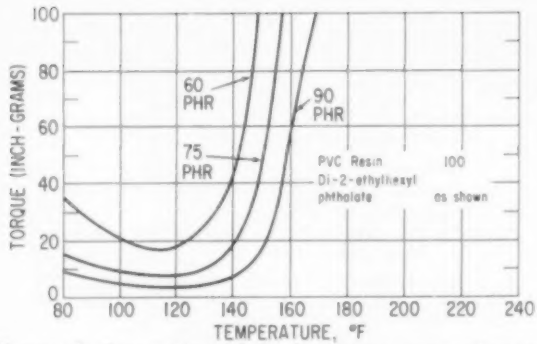

Figure 4. Increasing the plasticizer concentration raises the gel temperature

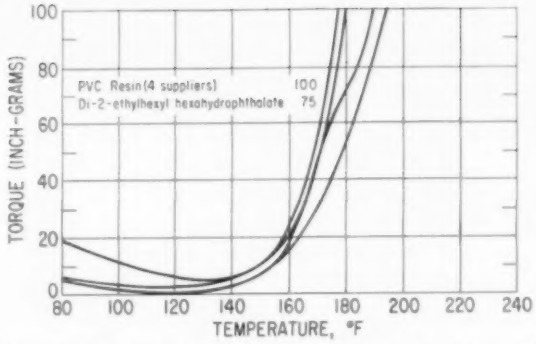

Figure 5. Resins from different suppliers show different gel rate curves

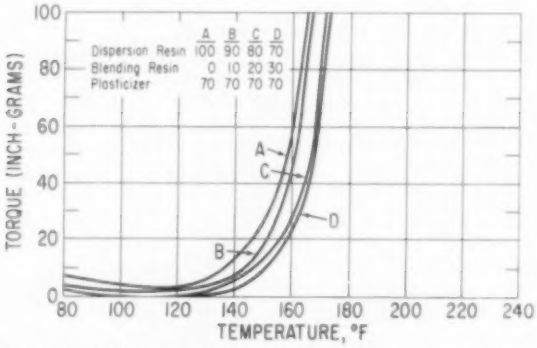

Figure 6. Addition of a blending resin serves to lower the viscosity of plastisols

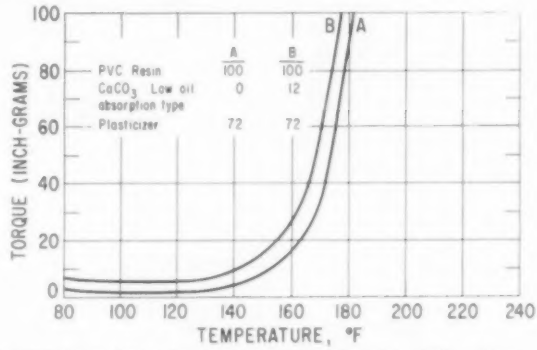

Figure 7. Addition of calcium carbonate filler lowers the gel rate

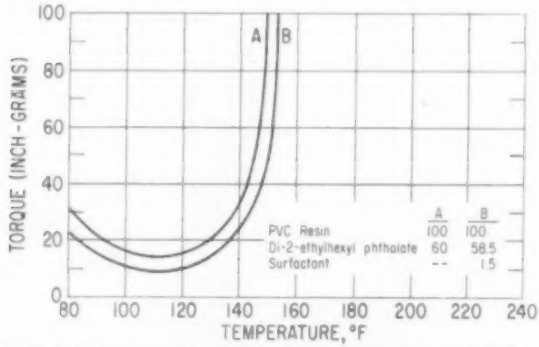

Figure 8. Compatible surfactant lowers the gel rate

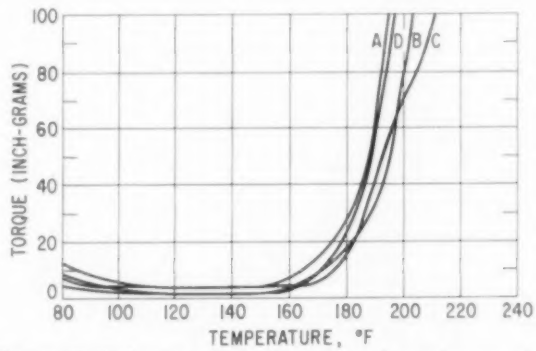

Figure 9. Gel rate curves of several minimum viscosity systems

steep in the gel region. Curve G and beyond define a region of slow gelation characterized by very low initial viscosities, little dependence of viscosity on temperature, and even shallower slopes in the gel region.

Plasticizer Blends—In view of the wide variety of end use requirements of plastisols, it is seldom that a single plasticizer is used in a given formulation. When using the gel-rate technique as a formulating tool, it is mandatory, therefore, that changes in gel-rate as a function of plasticizer blending be studied.

As indicated in *Figure 3*, the following generalizations can be made: If the plasticizers being blended are of approximately the same solvating power, the curve will be a weighted average of the curves for the pure materials; if, however, the plasticizers are of different solvating power, the resultant curve will be displaced toward the curve for the higher solvating plasticizer.

Plasticizer Concentration—Another formulating variable is noted in *Figure 4* in which the concentration of plasticizer in the plastisol was varied. From these curves, it is noted that an increase in plasticizer content raises the gel temperature. The specific effect depends on the nature of the resin and plasticizer. In general, the concentration effect increases as the solvating power of the plasticizer decreases.

Resin Choice—*Figure 5* clearly indicates that gel-rate of a plastisol is a function of resin choice. Superimposed on this factor is the solvating power and concentration of the plasticizer. At a relatively low concentration of plasticizer or when a high solvating system is used, differences between resins are minimized. As concentration is increased and/or the solvating power of the plasticizer blend is decreased, variation due to resin choice is maxi-

mized. Broad generalizations should be avoided due to lot-to-lot variation in resins.

Blending Resin—The addition of a large particle size blending resin in admixture with conventional stir-in resins is a widely used technique to lower the viscosity of plastisols. *Figure 6* shows the effect of such addition on gel-rate over a range of zero to thirty per cent blending resin, other formulating parameters being held constant. The resultant plastisol exhibits slower gelation with a broader minimum viscosity range as the concentration of blending resin is increased.

Filler Addition—Fillers, generally of the calcium carbonate type, are added to plastisols to decrease gloss, improve economics, provide opacity to the compound and to gain an improved hand in the finished vinyl article. The addition of such a material, as shown in *Figure 7*, will increase gel-rate of the plastisol, other constituents of the formulation being held constant.

Viscosity Depressants—The increased demand for lower viscosity plastisols has brought about the use of surfactants to not only lower apparent viscosity, but also to improve viscosity stability. This formulating technique is extremely valuable when low plasticizer concentrations are required.

Figure 8 is the gel-rate curves for two plastisols, identical except for the addition of surfactant. As expected, plastisol B, containing 1.5 PHR of a compatible surfactant has a lower initial viscosity, a lower viscosity minimum and a slower gel-rate.

Stabilizer Choice—While the choice and concentration of stabilizer system will exert a slight effect on the gelation characteristics of the plastisol in which it is used, the wide variety of heat stabilizers currently available on the market makes this a highly specialized study. Rather than restrict a gel-rate comparison to a relatively small number of specific systems, problems are approached individually.

Minimum Viscosity Plasticizer Systems as Determined by Gel-Rate

As primary plasticizer is replaced part for part by a secondary plasticizer, the viscosity of the resultant plastisol may first decrease and then increase. The phenomena of oversolvation and undersolvation exert similar effects in plastisols as they do in solution coatings. The amount of secondary plasticizer required to achieve a minimum viscosity system varies with the particular primary and secondary plasticizer employed. It is possible to predict the existence of a minimum viscosity system by gel-rate determinations. The plastisols whose curves are shown in *Figure 9* exhibit a viscosity minimum at twenty per cent extension as determined by a Brookfield viscometer. This coincides with the curve representing the slowest gelling system. The approach, from data collected thus far, is general in nature.

The ultimate value in the data and method herein presented lies in the fact that there has been developed a new instrument which will yield laboratory data that correlates with results obtained under actual plant conditions.

Literature References

1. Todd, Esarove, Smith, *Modern Plastics*, 34, 159 (1956)
2. Alter, *J. App. Polymer Sci*, Vol. II, No. 6, 312-317 (1959)

Acknowledgments

The author wishes to acknowledge the assistance provided by Messrs. V. Jackman and A. E. Foertsch of the Mellon Institute Department of Instrumentation and by Messrs. W. H. McKnight and W. R. Annonio of Union Carbide Plastics Company in the design of the tester.

Grateful thanks are also extended to Mr. C. W. Johnson for the conduct of much of the laboratory work.

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9. **Plastics in the Shoe Industry**—St. Louis Section, 11 papers, $3.00 members, $4.50 non-members. (See program, September 1959 SPE Journal, page 820).
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11. **Vinyl Plastics**—Cleveland Section, 8 papers, $2.50 members; $3.75, non-members. (See program, SPE Journal, August, 1959 issue, p. 745).
12. **Plastics Finishing**—Buffalo Section, 4 papers, $2.00, members; $3.00 non-members. (See program, SPE Journal, September, 1959 issue, page 823).
13. **A Designer's Look at Reinforced Plastics**—from the Pleasure Boat; Aircraft and Missile Industries Viewpoint—North Texas Section, 6 papers. $2.00; members; $3.00, non-members. (See program SPE Journal, April 1959, p. 324).

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14. **Vol. I—Quality Control for Plastics Engineers**—Lawrence M. Debing Ed., Reinhold Publishing Company 1957, 140 pages, $3.98, members; $4.95, non-members.
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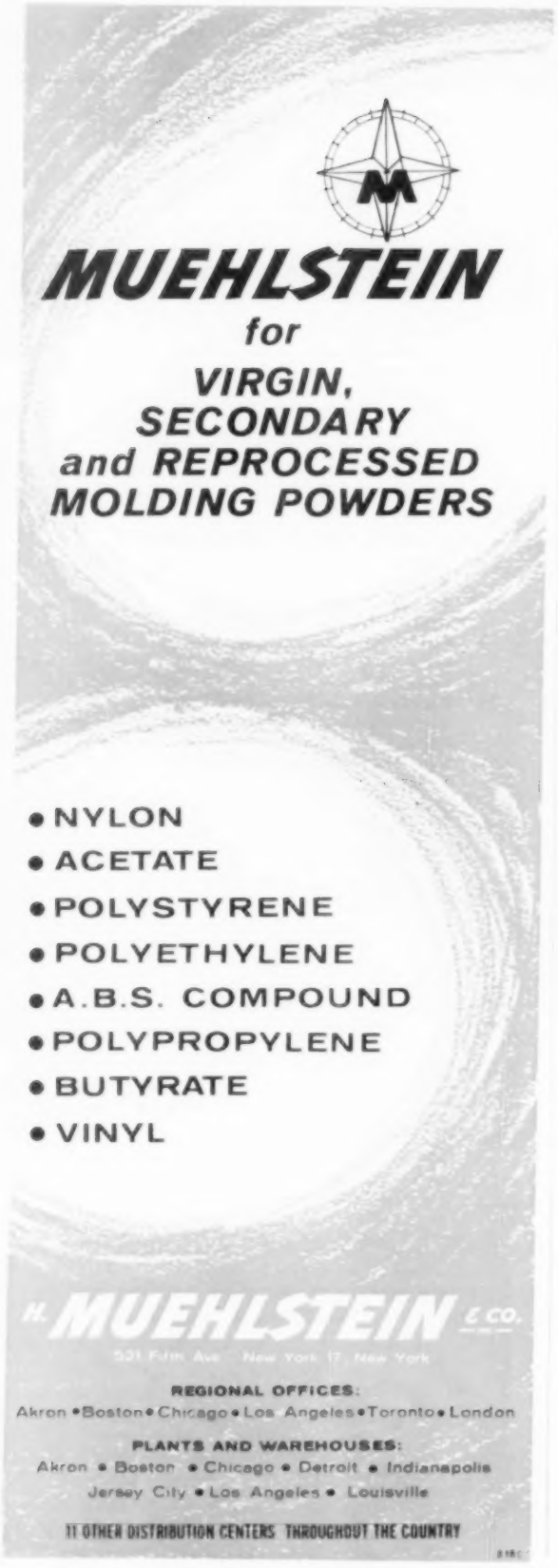

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TECHNICAL MEETINGS CALENDAR

1961 RETECS

March 14—Plastics Finishing Seminar sponsored by Southern California Section with cooperation of Finishing PAG, Roger Young Auditorium, Los Angeles, Calif. Chairman: Milton T. Schimmel, c/o Decorative Engineering and Supply, Inc., 17000 South Western Ave., Gardena, Calif.

April 4-5—Plastics Injection Molding Workshop sponsored by Pioneer Valley Section with cooperation of Injection Molding PAG, Holy Cross College, Worcester, Mass. Chairman: Roger Johnston, c/o Foster Grant Co., Inc., 289 North Main St., Leominster, Mass.

April 20—Plastics—A New Dimension in Buildings sponsored by Western New England Section with cooperation of Plastics in Buildings PAG, Springfield Museum of Art, Springfield, Mass. Chairman: Robert W. Sherman, c/o Union Carbide Plastics Co., 410 Asylum St., Hartford 3, Conn.

May 9— Plastics in the Automotive Industry sponsored by Detroit Section with cooperation of Plastics in the Automotive Industry PAG, Detroit Mich. Co-Chairmen: John A. McPherson, c/o Underground Products Inc., 12801 Inkster St., Livonia, Mich., and John J. Doyle c/o Rohm & Haas Co., 20211 Greenfield St., Detroit 35, Mich.

June 14—Plastics in Packaging sponsored by Quebec Section, Montreal, Quebec, Canada. Chairman: Ralph Noble, c/o Canadian Industries, Ltd., P.O. Box 10, Montreal, Quebec, Canada.

September 12—Plastics for Tooling sponsored by Central Indiana Section, Hotel Severin, Indianapolis, Ind. Chairman: Eugene C. Quear, c/o Delco-Remy Division, General Motors Corp., 2401 Columbus Ave., Anderson, Ind.

October 5—Plastics Foams sponsored by Buffalo Section. Section President: William Dunmyer, c/o The Carborundum Co., Building 71-1, Buffalo Ave., Niagara Falls, N. Y.

October 25—Plastics in Major Household Appliances sponsored by Kentuckiana Section, Louisville, Ky, Chairman: Ray E. Eshenaur, c/o General Electric Company, AP-5-249, Appliance Park, Louisville, Ky.

SECTION NEWS

Buffalo

Spark Machining in Mold Making

JACK VALENTINE

(Durez Div., Hooker Chemical Corporation)

The regular monthly meeting of the Buffalo Section, SPE, was held on December 12, 1960. About thirty members heard Mr. Kenneth Birch, Manager of Electro Processes Company, Toronto, Ontario, discuss "Mold Making by Spark Machining".

During his most interesting talk, Mr. Birch mentioned that spark machining is the greatest advance in mold making in a century. It does not compete with other methods of mold making, it complements them.

The outstanding advantages of spark machining are: (1) that the mold material is first hardened, then machined, (2) there is no pressure exerted on the part during machining, and (3) no polishing is required, a mottle finish being produced.

Buffalo

Nylon and its Applications

ANDREW J. HAMMERL

(Hooker Chemical Corporation)

The Buffalo Section met on November 14, 1960 at the Continental Inn. After dinner, Mr. George Kovach of the Foster Grant Company, Chicago, Illinois, spoke on Nylon and its applications.

Mr. Kovach described the nylon products of Foster Grant Company including Nylon 6. The applications and processing of these materials were discussed and the features of nylon elaborated.

Central New York Section

December Meeting A Sell-Out!

J. R. LAMPMAN

(General Electric Corporation)

A capacity crowd was on hand to greet Mr. George Taber, Supervisor of the Adhesives, Coatings and Sealers Laboratory at Minnesota Mining and Manufacturing Co. His illustrated talk on "Use of Adhesives with Plastics" triggered a large number of questions.

Membership Chairman Dan Malressay introduced guests that were present and called for more applications to be turned in.

President John Mills introduced Norman Berg as the new National Councilman for C.N.Y. Councilman Berg gave a short address after which a short time was allotted to Jim Lampman. He spoke on RETEC's and the plausability of C.N.Y. sponsorship for a RETEC. President Mills mentioned Iriquois Region P.A.G. advisor Grenier's forthcoming visit and the meeting planned for December 16th.

Education Chairman John Meyer then spoke on the plans for Student Visitation Day in March. 20 students will be invited and sponsors have already been chosen.

St. Louis

Aging of High Density Polyolefins

RICHARD H. KOEHRMANN

The November meeting of the St. Louis Section of the Society of Plastics Engineers was held at the Clayton Elks Club on November 21, 1960. Thirty members and guests were present with President B. M. Coons presiding.

Following dinner the speaker was Mr. Ray Davidson of the Celanese Polymer Co., Newark, N.J. whose subject was "Stress Cracking and Aging of High Density Polyolefins". The problem of mechanical and chemical stressing was covered and the talk was followed by a discussion period.

Pioneer Valley

Plastic Material of the Future

J. R. JOHNSTON

(Foster Grant Company)

On November 10, Bill Rittenhouse of Dow Chemical Company gave a very interesting talk and film on a new material "Derespan". This is essentially a combination of foam styrene with a surface of epoxy. The method of manufacture starts with mixing the styrene beads with a liquid epoxy resin and curing agent, which produce heat. The heat initiates further expansion and forces the epoxy out where it forms a surface skin or impregnates the abounding surface.

Connecticut

Pressure Forming of Sheet Plastics

KEN CLARKE

(E. I. du Pont de Nemours & Co., Inc.)

The December meeting of the Connecticut Chapter was held at the Fairway Restaurant in Bridgeport.

Guest speaker of the evening was Mr. E. Boyd Gardner of the Emhart Manufacturing Company, Hartford, Connecticut, who discussed "Pressure Forming of Sheet Plastics".

Mr. Gardner described in detail—well supplemented by descriptive slides—the techniques and equipment employed with this type of operation. A major advantage of pressure forming over vacuum forming is that much higher pressures are available, vacuum forming being limited to atmospheric pressure. The introduction of biaxially oriented sheet stock for packaging applications, such as Polyflex, emphasize the need for forming techniques providing higher pressures.

Baltimore-Washington

Filament-Wound Structures

STANLEY PROSEN

(Naval Ordnance Laboratory)

On November 15, 1960, at the Langley Park Hot Shoppes, the Baltimore-Washington Section of the SPE heard a presentation by Ralph Burkeley, Goodyear Aircraft Co., Akron, Ohio, on filament winding. Approximately 30 people were on hand. The title of Mr. Burkeley's talk was "A New Approach to Reliability in Filament Wound Structures".

Mr. Burkeley introduced the audience to filament winding, discussing the rocket motor needs of 1954 to present, and showing how the filament winding industry has progressed because of the needs of the rocket motor.

In the latter part of his talk, Mr. Burkeley discussed a quality control technique with intriguing possibilities. Together with the glass windings, Mr. Burkeley proposes to wind in a metallic-coated filament, which he referred to as the strain element. Since this element would have a known resistance, he could connect electrodes to it and take measurements at intervals to determine case damage, such as an open circuit indicating a damaged element and consequently a damaged case. The many possibilities of such an element and ways this could be used in quality control were discussed.

Northwest Pennsylvania

LLOYD ENGLISH

(Marx Co., Inc. of Pennsylvania)

A dinner meeting on November 17th at the Eagle's Club was called to order by Section President Fred Kraft with 52 members and guests present.

After introductory remarks by Mr. Clifford Scantlebury, an interesting film "Toshiba in Progress" was shown portraying development of modern industry in Japan since World War II. An interesting discussion followed with comments by Mr. Raymond Lohr on industrial conditions in that country based on his personal observations during a recent trip to Tokyo.

New York

Two Specifications Talks Scheduled

A. E. WHITNEY, JR.

(Goodyear Tire & Rubber Company)

The New York Section of SPE Vinyl Group, will have the following program for its February 15, 1961, meeting. Mr. Henry Collins of Underwriter Laboratories will speak on "Underwriter Laboratories' Specifications for Wire and Cable." On March 15, 1961, Dr. A. Zettlemoyer of Lehigh University, a member of the Vinyl Flooring Institute, will speak on "Vinyl Flooring Specifications".

Both of these meetings will be held at the Governor Clinton Hotel, Seventh Avenue and 31st Street, New York City.

Eastern New England

Annual Student Night

D. V. ROSATO

(Raytheon Company)

Date: March 28, 1961, Tuesday—*Student Night*

Place: Armand's Beacon Terrace Route No. 9, Framingham, Mass.

Time: 6-7 p.m. Cocktails
7-8 p.m. Dinner
8 p.m. Meeting

Speaker—Prof. Louis F. Rahm of Princeton University

Topic—"*Plastics As An Engineering Career*"

A discussion will be given on:

1. The various fields of occupation in the industry.
2. Specific activities in each.
3. The educational requirements.

This monthly meeting will be held with the "Student Visitation Night". Many students from high school and early college level will be attending the meeting.

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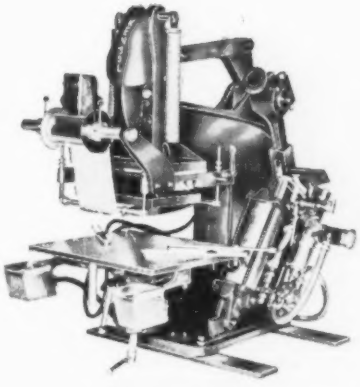

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Forming PAG Active in Many Areas

The PAG on Forming started the year 1960 with the following philosophy: The desired end of the PAG on Forming is to establish itself as a noteworthy component of SPE.

It was decided that the attainment of this end should be accomplished by excelling in the following areas:

- Usefulness to the members of the group.
- Usefulness to other SPE groups, ANTEC committee, local sections, etc.
- Usefulness to individuals asking assistance.
- Obtain a large active membership.
- Be well known and respected in the field.

Needless to say, the PAG on Forming did not obtain excellence in as short a time as one year; however, encouraging progress was made.

The following progress was made on development of information of value to the members of the group:

1. Brochures on the commercially available thermoforming equipment, both domestic and European, have been made available. Catalogs from a large number of both domestic and European manufacturers have been obtained. The data from these catalogs must be summarized.
2. Development of data on thermoforming of polypropylene. Data has been collected from polypropylene manufacturers. It is being summarized.
3. A paper on the techniques of thermoforming "difficult" materials such as Mylar and Nylon should be issued shortly.
4. A plan for the interchange of information between SPE and SPI forming groups has been set up.

The following assistance was given to other SPE groups.

1. A plan for the development of technical articles by colleges was presented to the SPE educational committee.
2. A report was sent to the Section Educational Committee chairman outlining a procedure for interesting high school students in plastics.
3. Reviews were set up for the 1961 ANTEC committee.
4. Papers were solicited for the 1962 ANTEC.
5. A list of speakers was sent to the New York section.
6. Assistance was given to the Binghamton Section in obtaining speakers for their Retec.

Individual requests for technical information on thermoforming were answered.

Most of the progress that has been reported has been due to the efforts of a very few individuals. It is felt that the group made its poorest showing in developing a large active membership.

The outlook for 1961 is good. At the 1961 ANTEC the PAG on Forming underwent an organizational change. Now there is a nine-man executive committee. Each committee member is in charge of some phase of the group's activity. It is felt that by having the committee operate in this manner that the group will be active in several different areas. The progress for the group will not depend upon the energy of one man, and a larger number of the members will be actively participating in the program.

Should any of you be interested in working with the group, your assistance would be most welcomed.

—— ■ ——

Edited by Saul Gobstein,
Chmn. PAG Exec. Comm.(Ferro Chemical Co.)

KANSAS CITY SECTION OFFERS COURSE

The Kansas City Section, in conjunction with the University of Kansas City has offered a course on plastics in the Fall 1960 semester and will be offering additional courses during the Spring 1961 semester.

The following classes will be offered as joint SPE and UKC efforts. Each would be offered at night in a series of two-hour classes as an extension course, not for credit.

1. Plastic Technology— *Part 2*

The following class outline would cover the basic chemistry of each resin type through the production methods and applications:

(a) Thermosetting Resins

1. epoxies
2. polyesters and alkyds
3. phenolics
4. silicones
5. polyurethanes
6. diallylphthalates, melamines and ureas
7. rubber compounding and molding

(b) Thermoplastic resins

8. nylon, polycarbonates and polyacetale
9. polyethylene and polypropylene
10. polystyrene and acrylic
11. vinyls and fluorocarbons
12. cellulosics

2. Chemistry of Plastics

No knowledge of chemistry required. A six-week course, two hours per week, covering the basic chemistry through the polymer preparation of resins and compounds used in plastics.

3. Polymer Chemistry

Requires one year organic chemistry pre-requisite or a course in chemistry of plastics to understand this course. A six-week, two hour per week course covering the theory of polymerization through the synthesis and manufacture of polymeric materials.

SOCIETY ACTION

President's Message and SPE Goals for 1961

Frank W. Reynolds, *SPE President*

The Society of Plastics Engineers is a young organization, only eighteen years old, having been chartered in 1942. Consequently, time has not permitted us to have established traditions, nor is our rut so deep that it defies change and flexibility consistent with our rapid membership growth and technological expansion of the plastics industry.

It is with this in mind, and as President of SPE, I am setting forth the proposed goals, or better still, achievements, for the year 1961.

To project with any reasonable accuracy the status of the Society twelve months from now we must apply the Monday morning quarter-backing technique or, in retrospect, examine the accomplishments for the year just passed.

A record, excellent or mediocre, becomes an entry in the history of the Society. The record of 1960 under the direction of President George Martin is unequivocally one of the best in our eighteen years of existence.

Let's look at a few major achievements:

A profound effect on the future of the SPE will be exerted by the new management organization just adopted by Council. Fundamentally, it grants a mutually acceptable and friendly divorce of the engineering and administrative affairs of the Society by delegating the responsibility to two separate boards, headed by the new elective officers, Vice-President, Engineering, and Vice-President, Administration.

Another major accomplishment was the elevation of the Professional Activity Groups, of which there are sixteen, to a prominent and influential position in which they are recognized as the principal and logical sources for engineering and scientific information for dissemination to industry.

The establishment of a central Technical Program Committee as the medium through which the technical program of the Annual Technical Conference is selected and implemented, thus providing international representation and continuity.

The completion of plans for the organization of an Educational Traveling Exhibit on Plastics in Building, sponsored by the Professional Activity Group of the same title. This technical exhibit is scheduled for sixteen museums throughout the country and will be shown over a period of 24 months.

SPE TRANSACTIONS, a new publication devoted to fundamental articles on plastics science and engineering of permanent reference value, was approved for publication beginning in January 1961.

These are a few of the outstanding accomplishments completed during the year 1960. Therefore, as your President for 1961, my job has been made much easier because of this excellent record. I propose to build on it, not stand on it, and with this idea in mind I submit the following projected goals for 1961:

PROSPECTIVE ACCOMPLISHMENTS FOR 1961

Past Presidents Advisory Board

Each member of this Board having been elected to the highest office in the Society, recognizes this honor and feels a sense of obligation to continue his service to SPE.

Since the most effective way that Past Presidents can serve is through their own Board, I propose a reactivation of the Board by more frequent meetings throughout the year to discuss and recommend adoption of programs aimed expressly at enhancing the prestige of the Society throughout the world. Relevant to this aim could be:

- Sponsorship of international achievement awards and mechanics for implementing.
- Increase in tenure of elected Officers and Executive Committee from one to two years.
- A meeting once or twice a year of all Presidents of selected engineering societies in the country to promulgate the potential influence of these societies on educational programs throughout the country.

Engineering Board Committees

1. **Professional Activity Groups**
   a. Substantially increase Sections' participation in the professional activity affairs by the establishment of Professional Activity Committees to work on projects of local need and interest or in cooperation with an existing PAG. Direct assistance in this objective can be had through the Regional Advisors.
   b. Define the responsibility of the new PAG Executive Committee and execute same.
   c. Cooperative assistance with the Technical Program Committee in establishing a superior technical program for the 18th ANTEC.
   d. Direct solicitation by each PAG to increase Society membership.
   e. Improve communications among all PAGs.
   f. Employ new technical staff assistant whose responsibility will be to work with all PAGs and the Technical Program Committees.
2. **Education Committee**
   Expand function to include direct promotion of specific educational programs at Section level.
3. **Meetings**
   a. Continue improvement in the quality of technical, engineering and scientific papers presented at ANTEC and RETECs through the facilities provided by the new SPE Technical Program Committee.

b. Conduct a study of Regional Technical Conferences based on the following factors, and make recommendations for each:

1. Desirability of limiting number in year.
2. Capability of Sections to organize and program a successful conference.
3. Desirability of a more equitable distribution of RETECs on a geographical basis
4. Proper consideration of subjects relative to their drawing power.
5. Advisability of each PAG sponsoring a conference pertinent to its area of interest.

4. **Publications**

Acquire 630 pages of Journal advertising, adhering to 45-55% ratio—advertising to editorial pages.

5. **Technical Volumes**

a. Prepare for publication and sale by January 1962 the engineering volume "Mechanical Properties and Design Methods for Plastics Materials".
b. Review outline of proposed volume, "Processing of Thermosetting Materials" and prepare for publication.
c. Resolve disposition of other volumes under consideration by the Technical Volumes Committee.

Administrative Board Committees

6. **Finance Committee**

Prepare and submit to the first 1961 Council meeting the budget for the 1961-1962 fiscal year after due consideration to the following factors:
a. Projected income and expenses to be estimated on a realistic basis consistent with increased activities of the Society and additional demands on the services of the Executive Office.
b. Final approval by the Finance Committee, Executive Committee and Council should be premised on no further changes and with complete adherence by the Executive Office.

7. **Public Relations**

Establish a planned program for the dissemination of information for the sole purpose of promoting SPE's interests through syndicated and local releases.

8. **Membership**

Increase membership (in good standing) by February 1, 1962 to 10,000.

9. **Credentials**

a. Determine the cause of delays in processing of applications and recommend corrective measures.
b. Clarify the qualifications for categorizing new members.

10. **New Sections Development**

Increase the number of new Sections by a minimum of two, making the total 47.

11. **Sections**

a. Study and recommend method for proportional voting representation by Sections on matters affecting Society policies.
b. Section meetings attendance—An appreciable drop in attendance at Section meetings throughout the country was noted during 1960. Conduct a thorough investigation of the cause of this situation in light of
Planned programs; Adequate meeting facilities; Central location of meeting place; Recommend corrective measures;

12. **Inter-Society Relations**

Formulate and implement plans for a more effective and mutually beneficial exchange of information between SPE and each of the thirty odd organizations represented by the Inter-Society Relations.

Ad Hoc Committees

13. **Committee to Study Desirability of SPE Engineering Displays**

Investigate all facets connected with the adoption of technical displays as an adjunct to ANTECs and RETECs, and prepare a detailed report and recommendation substantiating the proposal to Council for action at the October meeting.

14. **Committee to Study SPE–NCAEI Co-Sponsorship**

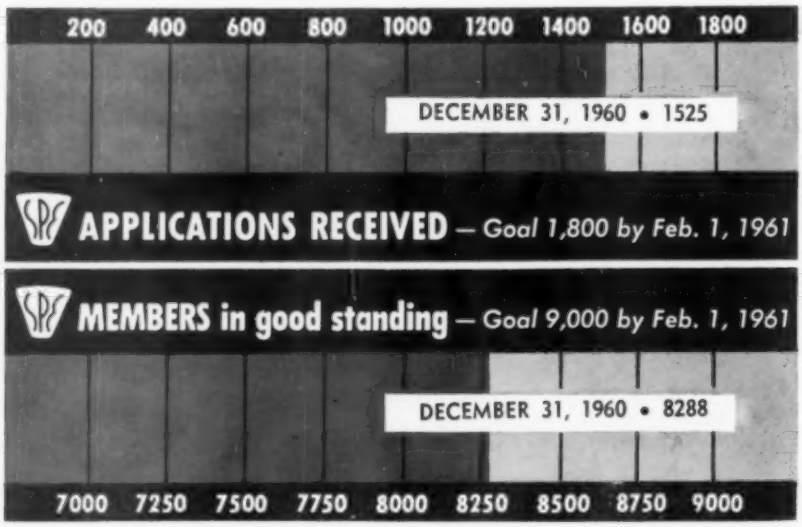
Prepare a detailed report and recommendation for Council action in October on the acceptance or rejection of the proposed co-sponsorship of SPE-NCAEI with respect to their annual meeting.

Executive Office

Maintain a well organized and efficient staff at all times consistent with its financial responsibilities and obligations to the expansion and growth of the Society by due consideration and execution of the following factors:

a. Adherence to approved yearly operating budget.
b. Planned and documented division of responsibility.
c. Documented job descriptions as a basis for performance ratings.
d. Maintain working conditions (housekeeping) conducive to efficient job performance.

These goals which are deemed practical and accomplishable will be attained through the earnest desire and diligent efforts of the Officers and Committees directing the affairs of the Society during 1961.

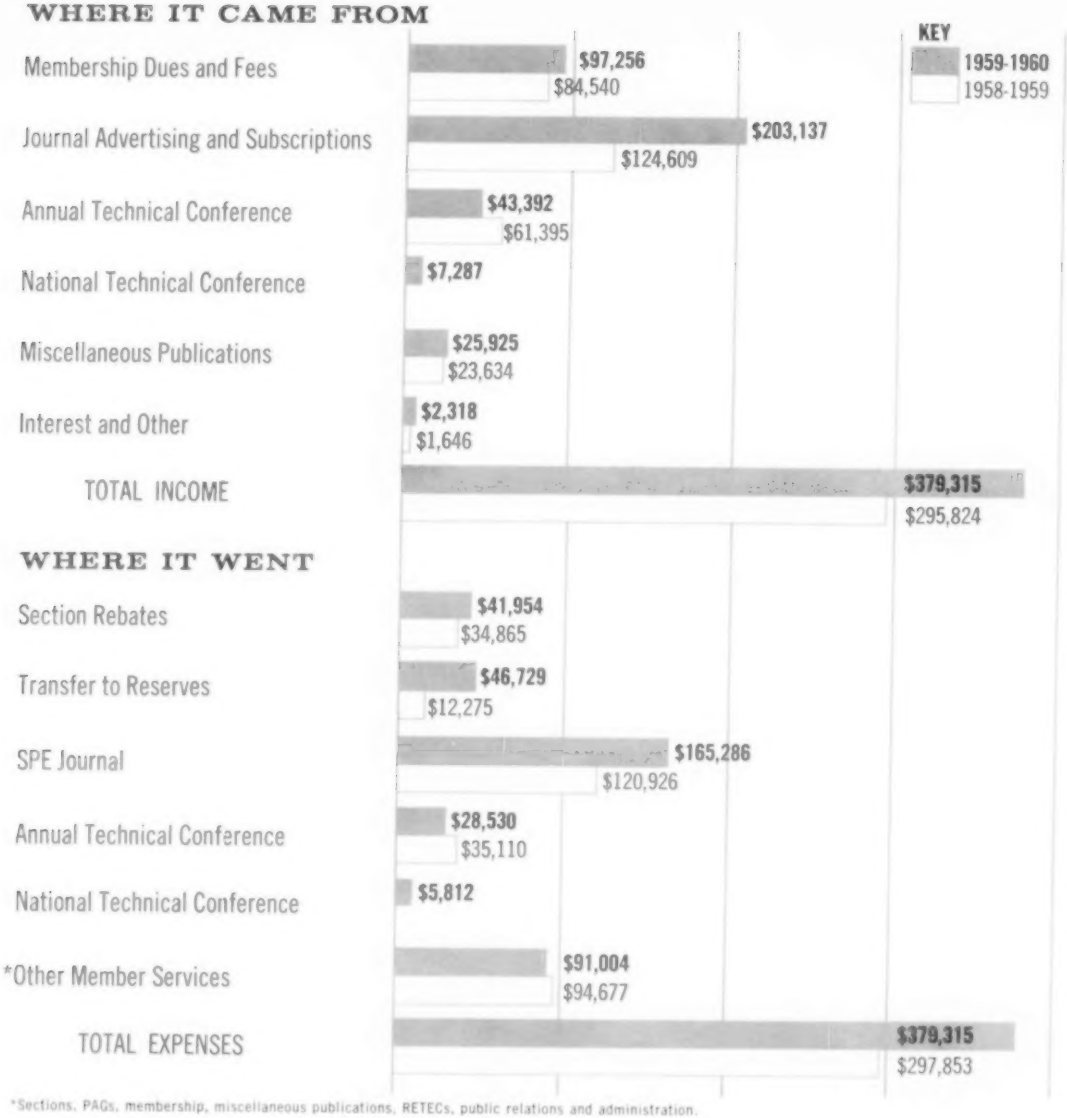


Edited by
Thomas A. Bissell,
Executive Secretary

The President's Annual Report 1960

SOCIETY OF PLASTICS ENGINEERS, INC.

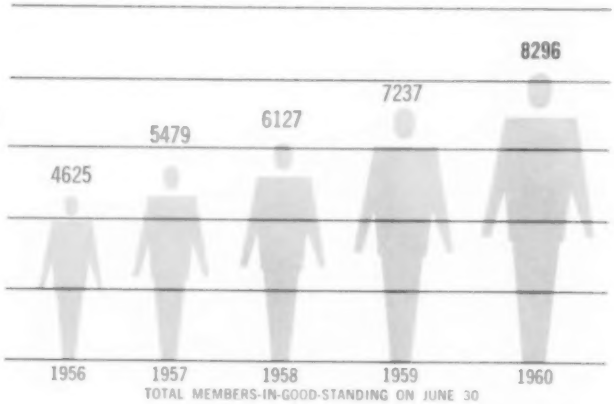
WHERE IT CAME FROM



WHERE IT WENT

*Sections, PAGs, membership, miscellaneous publications, RETECs, public relations and administration.

HOW MEMBERSHIP GREW



TOTAL MEMBERS-IN-GOOD-STANDING ON JUNE 30

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SOCIETY OF PLASTICS ENGINEERS, INC.
65 Prospect Street, Stamford, Connecticut

OFFICERS 1960

GEORGE W. MARTIN, President
FRANK W. REYNOLDS, First Vice President
HAIMAN S. NATHAN, Second Vice President
JAMES R. LAMPMAN, Secretary
JOSEPH B. SCHMITT, Treasurer
THOMAS A. BISSELL, Executive Secretary

TO MEMBERS OF SPE:

The basic responsibility of the SPE President is clear. At the conclusion of his term he must be able to indicate definite progress during his administration in attaining the Society's objective. In his own heart, he must know and feel that he has retired from office leaving the Society better equipped to serve the needs of its members than when he assumed the Presidency.

Based upon this interpretation of our duties, we believe our tenure has been one of accomplishment and we believe that this report proves it. Final judgment, however, must rest with you, the SPE member.

In this, our final written message as SPE President, we summarize Society activities for 1960. Admittedly, we have not achieved all of our goals of a year ago. But we did accomplish most of them — some with a wide margin. In developing these goals, however, we deliberately set our sights high so that they would present a challenge to all. Our members and various Committees rose to this challenge, and strove mightily to attain the goals. If some of them fell a little short, it certainly was not for lack of effort or enthusiasm.

Reports of all Administrators, Committee Chairmen, the Executive Secretary and a financial report are included on the pages that follow. We hope you will review these in detail.

In 1960 we have made considerable progress in many areas. The Professional Activity Groups have made giant strides toward becoming the strong technical arm of the Society with the assistance of a PAG Manual of Procedures, promotional brochure, membership survey, a new SPE Journal feature, and greater staff assistance — all provided during 1960.

Progress in the meetings, publications, Sections and membership areas has been featured by formation of the SPE Technical Program Committee, launching of SPE Transactions, a growing and improving SPE Journal, new Sections Manual of Procedures and 1800 new membership applications.

The dynamic program of our Education Committee has resulted in publication of a comprehensive survey of existing polymer courses and, with the assistance of the Membership and Student Membership Committees, a brochure to interest students in plastics engineering as a career.

No greater accomplishment was made during 1960 than the development and adoption of a revised organization for the Society management. It separates the engineering and management functions of the Society permitting each to receive the attention due them; and eases the growing load on Council.

Last but not least, in the Administrative area the Society is now on a firm financial footing and building for the future and the Executive Office has assumed a greater load of the administrative burden, leaving members freer to concentrate on technical activities.

For their sincere efforts, we offer our deep and humble thanks to all SPE members who have contributed so generously of their time and talents in 1960 and to the Executive Office staff. Without the wholehearted cooperation of all, our administration could never have realized its goals and given us a warm sense of accomplishment and satisfaction upon retirement as President.

In closing, we sincerely request that everyone continue to help the Society prosper and grow and that you provide our incoming President and his administration with the same unselfish support that characterized your efforts in 1960.

George W. Martin

PAST PRESIDENTS ADVISORY BOARD

R. KENNETH GOSSETT, Chairman

The Board is at present actively engaged in two major projects. The first is development of a program of awards for the Society. A proposal for an international award for outstanding contributions to plastics science and engineering will be presented to Council early in 1961. Considerable progress has been made on the second project — preparation of a history of the Society for publication in connection with SPE's 20th or 25th Anniversary. A wealth of material has been assembled and the first draft of the Society's initial five years has been written.

PROFESSIONAL ACTIVITY GROUPS AND TECHNICAL COMMITTEES

FRANK W. REYNOLDS, Administrator

PROFESSIONAL ACTIVITY GROUPS

Chairmen

1 Plastics in Buildings: Armand G. Winfield
2 Plastics in Electrical Insulation: Walter A. Gammel, Sr.
3 Extrusion: Ernest C. Bernhardt
4 Reinforced Plastics: George Lubin
5 Injection Molding: Roger B. Staub
6 Metal Mold Design and Construction: David R. Edgerton
7 Castings and Plastics Tooling: Lawrence Wittman
8 Forming: Donald N. Wood
9 Finishing: Thomas E. Hayden
10 Thermosetting Molding: Robert W. Bainbridge
11 Vinyl Plastics: Saul Gobstein
12 Polymer Structure and Properties: Herman S. Kaufman
13 Standards for Reporting Properties: Louis B. Allen
14 Plastics in the Automotive Industry: Richard C. Oglesby
15 Blow Molding: Harold M. Olson
16 Coloring of Plastics: Maret Bacci

Members of the Society and its governing body have, in the past year, come to recognize the Professional Activity Groups as the engineering and scientific voice of SPE. This recognition has resulted directly from three factors — aggressive Group leadership, well-planned and comprehensive programs of activity, and professional stature of the individual PAG members.

Concrete proof of this growing recognition is evidenced in the following 1960 PAG highlights.

1. Establishment of two new PAGs for Blow Molding and Coloring of Plastics. Both Groups have completed organization and undertaken initial projects.
2. Preparation, publication and distribution of a PAG brochure and accompanying survey of membership interests. From returns of this questionnaire a vitally needed mailing list of over 3000 members interested in one or more PAGs has been developed. An added "side benefit" has been an indication of specific areas of interest not currently served by existing PAGs.
3. Increased staff service to PAGs.
4. Active cooperation with the 17th ANTEC Committee in solicitation, review and recommendation of papers for the technical program. Even greater participation is proposed for the 18th ANTEC.
5. Inclusion in the revised organization of the Society's management of a more prominent position for PAG participation.
6. PAGs planned and organized technical programs of more RETECs than in any previous year.
7. Amendment of By-Law increasing the required number of signatures on a petition for a new PAG from a minimum of ten to twenty-five. This assures a greater opportunity for successful operation.
8. Complete revision of the PAG Manual of Procedures to conform to the growth of the Society and its plans for the future.
9. Initiation of periodic meetings of all PAG Chairmen for discussion and action on mutual problems.
10. Incorporation of a permanent feature entitled "PAG Progress" in the SPE Journal.

TECHNICAL INFORMATION COMMITTEE

WILLIAM O. BRACKEN, Chairman

Requests for technical information relating to plastics were answered during the year from twenty-five individuals, companies, educational institutions and scientific missions. These requests involved virtually the complete spectrum of the plastics industry from reinforced plastics to vinyls; films to foams.

INTER-SOCIETY RELATIONS, EDUCATION AND PLASTICS INSTITUTE

HAIMAN S. NATHAN, Administrator

INTER-SOCIETY RELATIONS COMMITTEE

ALBERT LIGHTBODY, Chairman

Liaison with twenty-three engineering and professional societies continued during the year and new appointments have been made to the Institute of the Aeronautical Sciences and the American Association for the Advancement of Science. At the request of the International Standards Organization two new appointees, representing both U. S. and Canadian SPE members, will serve on ISO/TC 61 Committee on Plastics.

A project has been initiated with the American Chemical Society to establish liaison at the local level in an effort to encourage greater cooperation among Sections of the two Societies. Another project is promotion of a change from the "English" to the metric or decimal system of measurement. As many other Societies have such work already well in hand, SPE efforts will be to aid in every manner possible.

EDUCATION COMMITTEE

CHARLES C. WINDING, Chairman

The Education Committee, one of the Society's most active groups in 1960, has made substantial contributions to the field of education in plastics engineering by:

1. Preparation and publication (in the December 1960 issue of SPE Journal) of a survey of courses of instruction in polymeric materials offered at the university level.
2. With the assistance of the Membership and Student Membership Committees, preparation and publication of a brochure, "Plastics as an Engineering Career," designed to interest high school students in a career in plastics engineering.
3. Compilation of a recommended list of books on plastics to be distributed to libraries.

Projects in process and scheduled for completion in 1961 are:

4. Revision of an existing brochure "Engineering Education in Plastics" which will give the interested student more complete information on a career in plastics.
5. Development of a revised Manual of Procedures for use by Chairmen of Section Education Committees.
6. Survey and review of non-degree instruction in plastics.
7. Preparation of a slide collection for use in plastics courses.

PLASTICS INSTITUTE COMMITTEE

LOUIS F. RAHM, Chairman

Early in the year this Committee modified original plans for the proposed Plastics Institute of America and engaged professional public relations counsel to augment promotion efforts.

Two surveys of some 1800 organizations in the plastics industry and Government agencies produced valuable information regarding the Institute. Results of the first, a research questionnaire with a response of 18%, indicated research fields of common interest and desire to employ professional graduates of the Institute. Response to the second survey concerning degree of interest, potential support, membership and possible locations was 20% of the mailing list.

With the survey task completed, the Committee is studying results and plans to make a final recommendation at the 1961 ANTEC.

MEETINGS

FRANKLIN L. FINE, Administrator

MEETINGS COMMITTEE

GUY A. MARTINELLI, Chairman

A very significant milestone in this area was establishment of the Technical Program Committee to plan, organize and implement the ANTEC technical program starting with the 1962 meeting in Pittsburgh. As a separate standing committee of the Society, this new group will solicit, review and select abstracts and papers and organize these papers into technical sessions. Membership of the Committee is extremely broad, representing all segments of the Society having an interest in composition of the ANTEC program. A major innovation is transfer of much of the routine work heretofore performed by the sponsoring Section's Speakers' Chairman to an SPE staff member acting as secretary of the Committee.

ANTEC SUBCOMMITTEE

CARL H. WHITLOCK, Chairman

The 16th ANTEC was held at the Conrad Hilton Hotel, Chicago, January 12-15, 1960 sponsored by the Chicago Section. Registration was 2,484; 84 papers were presented; and the Conference contributed a net of $21,878.17 to support the Society's activities. For the first time the SPE Executive Office handled company and individual registrations, including hospitality suites, information and new member desks; and most of the printing including final program. Also, for the first time, afternoon sessions were concluded early to allow time for PAG meetings without conflict from technical sessions.

Plans for the 17th ANTEC, sponsored by the Baltimore-Washington Section, are virtually completed.

Sponsoring Sections for future ANTECs are as follows:

1962—Pittsburgh	1964—Philadelphia
1963—Southern California	1965—Eastern New England

RETEC SUBCOMMITTEE

SAMUEL H. GREENWOOD, Chairman

Two SPE attendance records were broken by the six RETECs held during 1960. The average registration of 302, and the registration of 679 at the Newark Section RETEC both established new SPE marks. Attendance at all six 1960 RETECs was as follows:

1960 DATE	SPONSORING SECTION	SUBJECT	REGISTRATION
April 20	North Texas	"Plastics in the Petroleum and Chemical Industries"	139
Sept. 8-9	Eastern New England	"New Horizons in Vinyls and Plastics in the Shoe Industry"	388
Sept. 22	Binghamton	"Plastics in Business Machines"	237
Oct. 5	Golden Gate	"Plastics vs Corrosion"	155
Nov. 7	Ontario	"Automation in Injection and Compression Molding"	209
Nov. 18	Newark	"Blow Molding Comes of Age"	679

Eleven RETECs have been approved for 1961 — five in Spring and six in the Fall. For the North Texas Section RETEC on "Plastics in Packaging" on November 2 and 3, authorization, on a trial basis only, was granted for an engineering exhibition. Sponsorship of two-day RETECs was also approved and the RETEC Manual of Procedures was revised.

PUBLICATIONS

MAURICE F. MALONE, Administrator

PUBLICATIONS COMMITTEE

ALEX SACHER, Chairman

Considerable time and effort was expended during 1960 in laying groundwork for the Society's newest publication, SPE Transactions, which will be launched in January 1961. Response to this quarterly fundamental publication has been extremely encouraging with over 800 subscriptions, many for a three-year period, currently on hand.

Mark D. Inskeep assumed on November 1 the new post of technical editor for both the SPE Journal and SPE Transactions.

Staff written articles appeared for the first time in the SPE Journal and a special series of equipment maintenance papers were also published. Greater coverage of technical meetings by the editors has resulted in presentation of a wider variety of articles, which, in many instances, have been briefed and tailored toward Journal readership.

A total of 1374 pages were published in the Journal in 1960—an increase of 23% over the 1118 published in 1959. Print order for the December 1960 issue was 10,308 or approximately 1500 copies more than the average for last year. This extended coverage reflects both increased SPE membership and greater non-member circulation.

To assure adequate editorial coverage the Journal will maintain a 55% to 45% ratio of editorial pages to advertising pages during 1961.

The 573 advertising pages published in 1960 are 31% more than the 437 pages in 1959. This increase assures continuance of the Journal as a self-sustaining publication.

To develop adequately the Journal's advertising potential, an additional advertising salesman has been authorized for 1961 to assist in covering the Eastern territory. Also, during 1960 increased advertising rates, based on the increased circulation, went into effect.

EDITORIAL ADVISORY BOARD

FRANK W. REINHART, Chairman

Membership of this Board will be increased to 21 so it will be in a position to solicit and review articles for SPE Transactions as well as for the SPE Journal. From the members of this Board, the Chairman has appointed monitors or specialists to handle papers in professional fields relating to plastics. The help of the various PAGs is also being utilized in selection and review of articles for publication.

TECHNICAL VOLUMES COMMITTEE

HIRAM C. MCCANN, Chairman

Following the successful Volume II "Processing of Thermoplastic Materials" published in 1959, a volume entitled "Mechanical Properties and Design Methods of Polymers" will be the next publication in the SPE Plastics Engineering Series. For this volume an editor has been selected and he will hold a meeting with his authors during the 17th ANTEC. An editor has also been selected and an outline presented for a fourth volume, "Processing of Thermoset Resins." Additional volumes on molecular engineering and mold engineering and design are under consideration by the Committee.

ADMINISTRATIVE Joseph B. Schmitt, Administrator

FINANCE COMMITTEE
R. Kenneth Gossett, Chairman

During 1960 a budget for the 1960-61 fiscal year was submitted and approved with total income in the amount of $436,140.25. In furthering long-range plans to develop a surplus equivalent to one year's budget, the Society added $46,729.26 to its surplus making a total surplus as of June 30, 1960, of $101,810.45. A substantial increase in this figure is budgeted for the fiscal year 1960-61. During the year a building reserve fund, supported by an automatic deduction of $2.00 from membership dues, was established. A pension plan for members of the Society staff was inaugurated and adopted by Council effective January 1, 1961. Comparative financial statements for the 1959-60 and 1958-59 fiscal years are included in this report.

PUBLIC RELATIONS COMMITTEE
Frederick C. Sutro, Jr., Chairman

A major step in strengthening the Society's public relations program was appointment of Regional Public Relations Advisors in 18 key U. S. and Canadian metropolitan areas. These professional public relations executives will render advisory assistance to both SPE staff and to Section Publicity Chairmen within their region. Effective employment of their contacts and experience should greatly enhance SPE prestige on a local level by increasing the effectiveness of public relations activities.

Initial phases of a comprehensive, staff directed public relations program, with particular emphasis on the technical press, were instituted in 1960. Activities of this initial program were based upon substantially increased written and personal contact with editors of trade publications and involved publicity of Society meetings, publications, activities and prominent personalities. It is anticipated that this program will eventually be expanded to cover industry executives, newspapers and other media in an effort to establish SPE in its rightful place as the strong technical arm of the plastics industry.

CONSTITUTION AND BY-LAWS COMMITTEE
John M. Berutich, Chairman

This "behind-the-scenes" Committee handled implementation of a number of important By-Law changes involving virtually every segment of the Society. Among the more important changes were those concerning adoption of the new organization of the Society's management and those in the area of PAG organization and operation. Other major revisions provide for dues rebates for Student Members affiliated with a Section and for removal of Councilmen who fail to attend one of three consecutive meetings. Copies of the Constitution and By-Laws, up-to-date as of June 1, were distributed to Section Presidents and Councilmen.

NOMINATING COMMITTEE
Frederick C. Sutro, Jr., Chairman

ELECTION INSPECTORS COMMITTEE
Edward L. Larkin, Jr., Chairman

Nomination and election of the Society's 1961 Officers at the October 18 meeting of the SPE Council was handled in an efficient manner by these two Committees.

SECTIONS AND MEMBERSHIP James R. Lampman, Administrator

MEMBERSHIP COMMITTEE
Sherman M. Crawford, Chairman

With 1400 new membership applications received by December 1, opportunities of attaining this Committee's goal of 1800 new applications by February 1, 1961 appear excellent. This goal is an increase of 200 over that of 1959. Once again, however, it appears improbable that the President's membership goal will be reached. With 8,186 members-in-good-standing on December 1, over 400 new members per month are required to reach the goal of 9,000 members by February 1, 1961. Greatest contributing factor is the number of members delinquent in payment of 1960-61 dues who cannot be counted as members-in-good-standing. To combat this, Sections have been urged to appoint special committees to contact delinquent members personally and attempt to bring them "back into the fold".

The SPE Inter-Section Membership Contest, won last year by Bartlesville-Tulsa, has been continued again this year, but for a nine-month rather than a four-month period. In addition, an Inter-Regional Contest has been inaugurated with winning Sections in each of SPE's seven Regions to receive a banner. Competition has been extremely keen in both contests which terminate January 1. Winners will be announced at ANTEC.

STUDENT MEMBERSHIP SUBCOMMITTEE
Russell W. Ehlers, Chairman

To encourage Student Membership, an "International Student Visitation Day" has been established. Sections have been encouraged to invite students once each year to a specially planned Section meeting. First Sections to institute the program have reported an overwhelming success.

CREDENTIALS COMMITTEE
Donald W. Biklen, Chairman

Credentials procedures have been thoughtfully restudied with the double aim of speeding up processing and evaluating applications more accurately. Even greater speed and accuracy is anticipated in the future as a result of many helpful suggestions received from Officers, Members, and Executive Office staff.

NEW SECTIONS DEVELOPMENT COMMITTEE
Paul A. West, Chairman

SPE's 45th Section — Arizona — was approved by Council in May and its charter was formally presented by President Martin in June. Currently, a number of areas show particular promise of fostering new Sections and the work of the Committee in developing their potential in 1960 should bear fruit in 1961.

SECTIONS COMMITTEE
G. Palmer Humphrey, Chairman

In August the new Sections Manual of Procedures was distributed to Section Officers and Board members. A monumental task, this Manual is the first comprehensive compilation of the most effective operational procedures of SPE Sections and other engineering societies. As such it provides Sections with a guide for virtually every segment of their operations and has already proved invaluable to Section Officers.

To assist Sections with needed information and solutions to problems and to provide much-needed liaison between Sections and the Society, SPE Officers have met with all but a few SPE Sections during 1960, and our new staff administrative assistant visited 28 Sections. The staff assistant's efforts were directed principally toward assisting Section Boards and RETEC Committees with specific operating problems.

SPEAKERS SUBCOMMITTEE
Donald E. Eells, Chairman

This Subcommittee was transferred early in 1960 from the Meetings to the Sections Committee as its functions in helping to provide speakers for Section meetings are more closely allied to the latter group. Late in the year a new Speakers List was distributed to Sections to aid in 1960-61 programming.

SOCIETY OF PLASTICS ENGINEERS, INC.

COMPARATIVE CONSOLIDATED BALANCE SHEETS

	as of June 30 1960	1959
ASSETS		
CURRENT ASSETS		
Cash in Checking Accounts	$ 23,148.70	$10,131.38
Cash Reserves — Savings	64,074.04	37,525.12
Petty Cash	100.00	100.00
Accounts Receivable — Advertisers	2,660.24	9,834.62
Inventory — Books and Supplies	9,736.63	6,990.60
Total Current Assets	99,719.61	64,581.72
CAPITAL ASSETS		
Furniture and Fixtures	1.00	1.00
PREPAID EXPENSES AND DEPOSITS		
Post Office Mail Deposits	840.54	599.61
Rent Security	1,564.50	1,564.50
ANTEC Advances or Expenses	4,000.00	3,944.22
Travel Advances	1,725.00	725.00
Other Advances	1,050.00	
Prepaid Insurance	344.32	
Payment to Dougherty & Co.		15,000.00
Total Prepaid Expenses and Deposits	9,524.36	21,833.33
TOTAL ASSETS	$109,244.97	$86,416.05
LIABILITIES		
CURRENT LIABILITIES		
Accounts Payable and Accrued Expenses	$ 1,652.82	$ 9,451.28
Dues Received in Advance	931.70	207.58
Rebates Payable — Sections		1,751.00
Due from Operating Fund to Contingency Reserve		15,000.000
Total Current Liabilities	2,584.52	26,409.86
DEFERRED INCOME		
ANTEC Registrations Received in Advance	4,850.00	4,925.00
RESERVES		
Contingency (contra)	23,343.47	7,715.92
Research (contra)	40,730.57	29,809.20
Total Reserve	64,074.04	37,525.12
SURPLUS		
Balance — July 1, 1959	17,556.07	
Balance — July 1, 1958		30,614.38
Less Cash Transferred to Contingency Fund		(11,029.61)
Surplus Adjusted		19,584.77
Excess Revenue	20,180.34	(2,028.70)
Total Surplus	37,736.41	17,556.07
TOTAL LIABILITIES	$109,244.97	$86,416.05

AD HOC COMMITTEES

FUTURE ORGANIZATION OF THE MANAGEMENT OF THE SOCIETY

R. KENNETH GOSSETT, Chairman

A comprehensive plan for reorganization and streamlining of the Society's management developed by this Committee was unanimously approved in principle by Council at its October 18 meeting. Basically, the new organization embodies a long overdue separation of engineering and administrative functions and places increased emphasis upon SPE's technical affairs. Activities of the new Engineering and Administrative Boards and an expanded Executive Committee will relieve the heavy load on Council, SPE's top governing body, and permit fewer and shorter meetings.

Favorable Council action on January 23, 1961 upon By-Law changes necessary to implement the new organization is required before the plan can go into operation. A detailed description of the new organization was published in the January 1961 issue of the SPE Journal and an organization chart will be published in the February 1961 Journal.

COUNCILMEN'S TRAVEL EXPENSE

RICHARD A. JENKINS, Chairman

This Committee submitted at the January 11 Council meeting a preliminary report which included the results of considerable research. At this meeting Council withheld action on the report until after action was completed on the proposal for the future organization of the management of the Society.

STUDY OF CO-SPONSORSHIP OF NATIONAL CONFERENCE ON APPLICATION OF ELECTRICAL INSULATION

MAURICE F. MALONE, Chairman

This Committee has been studying the pros and cons of the request of the Plastics in Electrical Insulation PAG to co-sponsor this Conference and Exhibit with the American Institute of Electrical Engineers and the National Electrical Manufacturers Association. The Committee expects to report at the Council meeting on January 23.

STUDY OF DESIRABILITY OF SPE ENGINEERING DISPLAYS

JOSEPH R. GRENIER, Chairman

Formed at the October 18 Council meeting, this Committee is now studying the experience of other engineering societies that sponsor engineering displays as an integral part of their meetings, and will report recommendations at the January 23 Council meeting.

EXECUTIVE OFFICE

THOMAS A. BISSELL, Executive Secretary

The following head up the SPE staff organization:

Lewis A. Bernhard, Manager, Administrative Department
Robert D. Forger, Administrative Assistant
Melvyn A. Kohudic, Publications Editor
Leon R. Noe, Advertising Manager, SPE Journal

During 1960 the SPE Executive Office staff continued to expand to meet the growing needs of the membership. By the time of the 17th ANTEC, full-time employees will number 18. A technical editor has been added to assist in editing the new SPE Transactions and the growing SPE Journal, and an advertising salesman has been added to assist the advertising manager in providing more complete coverage of the Eastern territory. To relieve the shortage of office space resulting from this and further growth, Council has authorized rental of additional space in the same building.

Considerably greater service has been provided to PAGs during 1960, and a staff member has assumed the responsibility of secretary of the new Technical Program Committee. He will take over much of the correspondence and routine formerly handled by the ANTEC Speakers' Chairmen. The administrative assistant participated in meetings of 28 Section Boards and or RETEC Committees to assist in Section and RETEC planning and operation. The staff Director of Public Relations worked with the Public Relations Committee to expand and accelerate the Society's public relations program.

The Executive Office staff is grateful to Council for providing during 1960 an adequate pension plan and traveling accident insurance. With hospitalization insurance, group life insurance, and annual physical examinations already provided, the staff is fortunate to have a complete package of fringe benefits.

As the Society's communications and publishing center, the Executive Office has been increasingly prolific during 1960. In addition to the SPE Journal, the new SPE Transactions, the ANTEC preprint book, this Annual Report, the ANTEC advance and final programs and the SPE Newsletter, the following are among the items edited, published, and distributed during 1960:

Sections Manual of Procedures

PAG Manual of Procedures

PAG promotional brochure and membership survey

Career brochure "Plastics as an Engineering Career"

Six RETEC preprint books

SPE Roster that, for the first time, lists titles and company affiliations of members

Special publication "Plastics for Architects, Artists and Interior Designers"

Revised membership brochure

Revised ANTEC and RETEC Manuals of Procedures

Revised Constitution, By-Laws and Rules

Hundreds of Committee meeting notices, agendas, reports and minutes

Promoted circulation of SPE Transactions resulting in more than 800 subscriptions as of December 1960

Prepared 5-year growth plan for Executive Office.

Monsanto

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materials that break
through the
price-performance
barrier!

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Take an existing product made with a common material, redesign and produce it with Lustran, and you will create a new product made with fewer pieces, little or no finishing, less labor, and at far lower cost than previously thought possible. You will have a product with an amazing combination of light weight, unusual toughness and durability. And it will have the sales appeal to help you increase volume—profitably.

Take that development product that's on the drawing board or the one that hasn't quite gelled in your mind . . . Lustran is the material to make these ideas come alive and earn profits. Or perhaps Lustran is the material needed to spark that elusive new product idea.

What is Lustran? Lustran is a unique composition of styrene and other monomeric materials produced by using an entirely new concept of molecular arrangement. It employs an advanced polymerization technique to meet the higher requirements of more applications more efficiently than ever before. Whether your product requires components that run two hundred to the pound or ten pounds each, Lustran is the material for rugged performance and profit improvement.

What are its properties? Lustran is so versatile that it can be formulated to meet a broad range of physical, chemical and price requirements. Lustran has a unique combination of effective strength, rigidity, and other desirable properties to a significantly high degree. One Lustran formulation, for example, has 4 times the impact resistance of rubber modified styrene, 10 times that of general purpose styrene. Lustran has exceptional impact and tensile strength, a vast color range, rigidity, abrasion and chemical resistance as well as efficient, economical processability. Products made with Lustran have excellent surface appearance, hardness and gloss. You can drive nails or turn screws into Lustran. At zero degrees Fahrenheit, a ⅛ inch thick 24 inch square sheet withstands the shock of 25 foot pounds. Under an 800 pound load, an automotive armrest made of Lustran remains intact while the supporting metal screws fail.

What are the uses for Lustran? Lustran has been successfully injection molded into parts weighing as much as 3½ pounds and vacuum formed in deep drawn parts weighing up to 11 pounds. It will find great demand in products which require high impact strength, rigidity, and breakage resistance in addition to the traditional important advantages of plastics . . . built-in color, corrosion resistance, single-piece construction. Lustran promises new developments in design and cost savings for new products, components and housings for business machines, automobiles, refrigerators, air conditioners, fans, radios, television, vacuum cleaners and other appliances, housewares, shoes, packages, pipe fittings and toys. Wherever performance and cost are critical, Lustran will find application.

What are its processing characteristics? Plastics converters who have worked with Lustran have been astonished at the superior thermal stability of Lustran. Over a wide range of temperatures, it is possible to produce components with excellent uniformity in color and physical properties . . . performance not always achieved with other styrene polymers. With Lustran you can achieve consistent color control even in softest pastels. It can be molded and extruded in standard equipment. Sheets of Lustran can be formed, fabricated, and decorated using conventional techniques.

Can you capitalize on this development now? Lustran is now available from interim production facilities which can meet anticipated commercial requirements. A fifty million pound plant is now under construction. It will be in operation the latter part of 1961. With the addition of the Lustran family of plastics to our familiar Lustrex styrene molding materials, Monsanto now supplies the broadest spectrum of styrene based materials.

An extensive program has been set up to acquaint plastics converters with the unique capabilities and business building opportunities of Lustran. Plastics converters are invited to contact the nearest Monsanto sales office for more information. Designers and manufacturers are invited to write for current data and progress reports to Monsanto Chemical Company, Plastics Division, Dept. 803, Springfield 2, Massachusetts.

LUSTRAN, LUSTREX: Reg. U. S. Pat. Off.

Monsanto

MONSANTO INNOVATOR IN **PLASTICS**

ABOUT MEMBERS

Howard C. Cookingham, V.P. of the Eastern New England Section of SPE, has been appointed Vice President of D. H. Litter Co., in charge of the New England Office. Mr. Cookingham, a graduate of Northeastern University, has been with D. H. Litter Co. since 1936.

Mr. Cookingham

Mr. Archinal

Walter C. Archinal has been appointed superintendent of coatings production at Metal and Thermit Corporation's Carrollton plant. Mr. Archinal, with M&T's Coatings Division since 1959 was formerly with Rubber Corp. of America.

W. J. Fitzgerald has been promoted from Manager of Plastics Applications to National Account Manager of the Plastics Division of Koppers Company, Inc.

Phillips Chemical Co. has reassigned two of its District Sales Engineers. **G. M. Tucker** goes from Chicago to Kansas City, Mo. and **K. L. Smalley** goes from Erie, Pa. to Detroit for the Plastics Sales Division.

Ferro Corp. has opened two new plants, a fiber glass and plastic colorant plant in North Miami, Florida and a colorant plant and warehouse in Elizabeth, N J. **J. Gerry Browne** will manage the Miami plant and **Robert J. Frawley** will supervise the Elizabeth plant.

Jack G. Fuller has resigned from Rexall Drug & Chemical Co. to become National Sales Manager for Ankerwerk International and Krauss-Maffei International, West German makers of reciprocating screw plasticizing injection molding machines. Office and service groups have been established in Bound Brook, N. J. and Santa Ana, Calif.

Allied Chemical's Plastics Division laboratory has named **Richard R. Merkel** group leader, plasticizers applications research and **John L. O'Toole,** group leader, testing and polymer characterization. Mr. Merkel holds a B. A. degree in chemistry from the University of Pennsylvania. Mr. O'Toole holds B.S. and M.S. degrees in chemical engineering from the Newark College of Engineering. Among new product managers for the division are **Stanley B. Mulder,** phenolic resins and **David W. Towler,** flurohalocarbon resins.

Herb. J. Weber, President, has announced the formation of a new company, Aard Plastics, Inc., in Paterson, N. J., specializing in the extrusion of all types of thermoplastic materials. **Henry Barbour** will be Plant Superintendent. Mr. Weber is a past president of the New York Section, SPE.

Harwick Standard Chemical Co. has named **J. H. FitzGerald** Manager of the company's Boston operation and **J. L. Weaver,** Manager of the Trenton operation. Mr. FitzGerald, a Massachusetts Institute of Technology graduate, was with B. F. Goodrich Co. before joining Harwick in 1950. Mr. Weaver, a graduate of Ohio State University, has been with Harwick since 1948.

Ron Wallace has been named Production Manager for Automatic Plastic Molding Co. of Berkeley, Calif. Mr. Wallace attended San Francisco State College.

Mr. Wallace

Peter D. Monti has been appointed optical stylist for Celanese Plastics Co. Mr. Monti, with Celanese since 1956, will direct the development of new concepts, designs and colors for optical frames formed from acetate sheet.

Leonard E. Canner and **Charles J. Chaban** will be Division Vice Presidents of the newly formed Coated Fabrics Division of Interchemical Corp. The division was formed from the Landers Corp., recently acquired by Interchemical.

Food Machinery and Chemical Corp. has named **Ronald L. DeHoff** as a market development representative of its Epoxy Department. Mr. DeHoff, formerly with Shell Chemical Co., received his B.S. degree in chemical engineering at the University of Alabama.

William H. Willert, vice president, has been named to the Board of Directors of Frank W. Egan & Co. Mr. Willert, with Egan since 1952, heads the Plastics Machinery Division.

Fred C. Sutro has left Spencer Chemical Co. to take the newly created position of Marketing Manager, Polyolefins of Cabot Corporation. Mr. Sutro is a past President of SPE.

The Jones-Dabney Company's Resins and Chemicals Division has opened three new sales territories, with **R. T. O'Connor** in New England, **R. L. Wheeler** in the Midwest and **G. V. Jenks** in Los Angeles. Mr. O'Connor, an SPE Journal author (April, 1960), was formerly Technical Director of Devcon Plastic Steel Corp.

H. D. Thweatt Company has been named Western New York representative of Thoreson-McCosh, Inc., manufacturers of hopper-dryers, loaders and granulators. **Mr. Thweatt** is active in the Buffalo Section of SPE.

OBITUARY

With deep regret the SPE learned of the recent death of **Mr. Benjamin H. Davis** of Davis Standard Division of Franklin Research and Development Corporation.

PLASTICS AROUND THE WORLD

This month's column has been made possible through the contributions of these abstracters:
Alexander Baczewski (L'Officiel des Matiéres Plastiques and Pensez Plastiques)
Alfred K. Alk (Poliplasti and Materie Plastiche)
Walter A. Gammel, Sr. (Rubber and Plastics Age, and ASTM Bulletin)
Evert A. Mol (British Plastics)
Samuel S. Oleesky (Plastics)
Trygvie Wold (Danish Plastics)

Denmark

PLASTICS

JULY 1960

Day Course at Technological Institute—pp 192

A short course of 30 hours was started Oct. 3rd for engineers and others connected with industry. The course will cover Automation and its different means—hydraulic, pneumatic, mechanical and electrical. It will also take in analysis of different production methods.

France

L'OFFICIEL DES MATIERES PLASTIQUES

NOVEMBER 1960

Non-supported Films—pp 801-807

The Salpa process used in France for the extrusion of poly(vinylchloride) makes use of a pump which constantly changes the air within the vinyl tube between extruder and rewind. This prevents the evaporation of plasticizer from hot parts of the tube and its condensation on colder spots. Montecatini in Italy splits the extruded polypropylene as soon as it is strong enough and cools it in a water bath. German and American Methods are mentioned.

An Economic Study of Compression Molding—pp 811-813

The influences of labor, mold costs, number of machines and number of cavities are shown in five graphs. A nomograph for the calculation of a minimum run of molded pieces is given.

Suction-forming—pp 814-816

Vinylchloride copolymers and cellulose acetate lend themselves to this technique. The rigid plastics are delivered in 5x5ft sheets. Molds are made from wood, plaster or polyester. The most critical part of the assembly is the pump. 7 drawings show molds and the arrangement of suction holes.

Foamed Plastics—pp 817-824

First installment of a series covering more than 10 resins and 5 techniques of introducing bubbles. Urea resins, phenoplasts, melamine resins, vinyl polymers and copolymers are treated extensively. Illustrations.

PENSEZ PLASTIQUES

NOVEMBER 1960

Plexiglas Improves Acoustic Reproduction—pp 13-16

A high fidelity system using an acrylic resin for baffles and loudspeaker housings is free of noxious vibrations, and lends itself to mass-production.

Plant Covers—pp 41-43

Melons have been grown underneath boxes made from translucent reinforced polyesters. The time of harvest has been advanced and the yield increased considerably. Italian and Belgian experiences in related fields are quoted extensively.

England

RUBBER AND PLASTICS AGE

AUGUST 1960

Leather and Synthetics—1960—p 903

The British Leather Institute's Council reports production of leather-soled footwear has dropped to 36% of total produced in England.

Silicones are used for waterproofing, polystyrene for ladies heels, nylon for football studs, PVC for welting, and uppers, and polyethylene, PVC and resin-rubber for soling. Natural consumption rubber remains fairly constant, but consumption of synthetic rubbers has doubled in three years.

Neoprene from Northern Ireland—pp 905-906

This article describes the first neoprene plant built by du Pont outside U.S.A., opened July 26, 1960 at Maydown, North Ireland. Its capacity is 22,000 long tons.

OCTOBER 1960

Synthetic Rubber is International—pp 1145-1146

Increased consumption of rubber due to expansion of motor industry, increased use of rubber in footwear, flooring, adhesives, textiles and the like.

Rubber consumption (world) estimated in long tons

Year	*Natural*	*Synthetic*
1950	1,722,500	500,000
1955	1,880,000	1,062,500
1959	2,112,500	1,575,000

World Synthetic Rubber Consumption and Production—pp 1154-1159

Rate of conversion from natural to synthetic rubber has been phenomenal the last five years. In Free World 21 new plants established between 1957-1960, and 24 announced through 1965.

NOTE: A detailed appendix lists all facilities by country, rubber type, estimated capacity, date, reported ultimate capacity, date, owner, location and comments.

Polyether-Based Flexible Urethane Foams—pp 1174-1178

A one shot process for flexible foams had not been possible with commonly available tertiary amine catalysts. Recently a weak base, but powerful catalyst, 1:4-diazabicyclo-(2:2:2)-octane (DABCO) has solved this.

A practical comment advising duplication of the activator metering system to handle silicone and non-silicone activators is given—to avoid collapse of polyester foams if these are run in same machine.

BRITISH PLASTICS

OCTOBER 1960

The Swelling and Fracture of Polymer Melts—pp 414-419

The subject covered in this article has long been one of the most baffling and challenging met by plastics fabricators, especially in the extrusion field. Swelling and fracture affects die design, product dimensions, product appearance, and, in extreme cases, product

strength. The mechanism behind swelling and fracture is by no means cleared up by the article but a variety of possibilities is suggested and discussed and give the reader a good idea of the complicated molecular phenomena that could be involved. The article is very worthwhile reading but the reader can only get the full benefit from it when he also tackles the extensive list of references. It takes quite a bit of background in the modern rheological theories to follow the authors to their conclusions.

PLASTICS

OCTOBER 1960

Plastics in Europe

In conjunction with the "Macroplastics 1960" conference at Utrecht, a comprehensive summary of about 20 pages is presented in this issue. The review encompasses activity and products in Holland, Germany, France, and Belgium. It also gives a complete list of the exhibitors and their products. Well worth reading.

The Biological Deterioration of Plastics

The subject of this research paper is an area of plastics which certainly merits attention, but which has never been covered in a comprehensive manner. The paper, as printed, is so concise that an abstract would amount to a repetition of the entire article. Consequently, only the section sub-headings will be given as an indication of the topics discussed:

1. Nature of biological deterioration
2. Microbiological deterioration
3. Vulnerability of synthetic polymers
4. Liability of plasticizers to damage
5. Some practical problems
6. Infestation of plastics by insects
7. Infestation of pure plastics
8. Mixtures of synthetic and natural substances
9. Infestation by rodents

A number of literature references are included.

The Ageing of Plastics—Part I

This is the first of a series of articles detailing an investigation into a problem of immense ramifications. The presentation in this section considers some of the internal factors affecting ageing and the external factors, such as thermal, chemical, and mechanical stress. Despite the deeply theoretical approach to the study, the paper is one of extreme practicality, and should be a distinct contribution to the literature.

Italy

Materie Plastiche

SEPTEMBER 1960

Use of Plastics in Agricultural Buildings with Particular Reference to the Conservation and Transformation of Products—pp 829-838

The greatest use of plastics in agriculture appears to be in irrigation piping. It has, incidentally, made a tremendous social and economic impact by allowing the use of arid lands previously unavailable. Irrigation through sprinklers attached to a permanent or portable net of conduits employs PVC rigid piping. Laterals and fittings of polyethylene are also popular. Some farmers are now applying fertilizers in the irrigation spray which has been possible only since the advent of chemically resistant plastics. One novel application is the protection of fruit trees from sudden drops in temperature. A fixed system of rigid PVC is employed to spray the trees when the temperature drops to within a few degrees of freezing so that the roots and trunk are covered with an insulating sheet of ice. Water is also applied by gravity using a flexible tube of polyethylene or PVC coated cloth which takes the place of a permanent delivery canal. The water loss through seepage and evaporation is eliminated since the water is uncovered only in the distribution channel. A large vineyard in France employs underground polyethylene piping for sulfur solutions which are applied to grapes immediately after a rain to prevent mold diseases, and a dairy sends milk on a 20 minute journey from field to factory through flexible piping. Another problem solved with plastic is the storage loss of water through seepage. In some soils 30-50% is so dissipated. Polyethylene or PVC sheeting used to line basins and aqueducts, nearly eliminates the loss. A third wide field for plastics is in greenhouses where rigid sheets or flexible films replace glass. Greenhouses may be brought to the fields in the form of flexible films which cover the growing seedlings. Black films perforated for the insertion of the plants have been used with great success to eliminate weeds and isolate the plants from soil borne diseases and fungi. Plastic films are being studied as portable covers for ensilage. In barn construction reinforced panels are replacing both glass and siding. In all Italy, the use of plastics in agriculture continues to increase.

POLIPLASTI

JULY-AUGUST 1960

Unification in the Plastics Sector—pp 19-23

In May 1940 the foundation was laid for unifying the plastic field in Italy under these three categories:

1) Classification and definition of plastics.
2) Definition of and standardization of test methods.
3) Dimensional unification of semi-finished and finished goods.

The author briefly recites the history of accomplishment, codifies recent changes and additions to the standards, reports those under discussion or in process of adoption and suggests future thinking.

SEPTEMBER-OCTOBER 1960

Molding Materials Reinforced With Glass Fibers—pp 41-47

Among newer materials in foreign markets are transfer or compression molding compounds reinforced with glass fibers for high and low pressure procedures. The author has gathered available information on the constitution, preparation and form of the compound, and the applications, production and characteristics of the articles molded.

Recent Developments in the Applications of Polyamide Resins—pp 5-15

Nylon in Italy is predominantly type 66. Its excellent physical properties have allowed a constant increase in use, and although it has competitors in newer and cheaper materials, its versatility is well demonstrated. The author describes other polyamides which are available, devotes considerable space to descriptions of current applications and exhorts his audience to consider wider employment of nylons in Italian industry.

Why the MOLD DESIGNER

talks D-M-E ECONOMY to the Mold Maker and Molder

Interchangeability of D-M-E Standard Mold Bases Leads to Extra Savings!

Specifying D-M-E Standard Mold Bases and component parts reduces mold cost, saves time, and provides an unlimited variety of plastic mold assemblies.

D-M-E standard components are fully interchangeable: Replacements can be made without special fitting or reworking. Cavity plates and components can easily and quickly be removed and replaced in perfect alignment.

Whether for injection or compression molding, D-M-E Standard Mold Bases enable you to work with greater flexibility by providing a selection of over 7,000 cataloged mold base combinations! And D-M-E Master Layouts enable designers to devote more time to cavity layout.

MOLD MAKER: D-M-E first-quality carbon or alloy steel assures easier and more reliable machining. And D-M-E Standard Mold Bases have exclusive built-in features at standard cost: surfaces ground flat and square; patented tubular dowels; one-piece ejector housing; stop pins welded to ejector plate; 33 sizes from 9⅞" x 8" to 23¾" x 35½".

MOLDER: D-M-E Standard Mold Bases and components reduce maintenance. They are carried *in stock* at your local D-M-E Branch ready for quick delivery. You eliminate waiting, cut downtime, reduce your inventory and maintain production schedules. With D-M-E you get supplies when you need them from a single reliable source!

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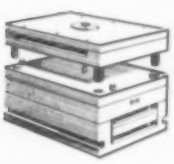
61-A-P



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SPE Section to Sponsor Injection Molding Educational Workshop

Continuing the very successful SPE educational Workshops, the Pioneer Valley Section of the Society of Plastics Engineers will sponsor a two-day Workshop or "refresher course" in injection molding on April 4 and 5, at Holy Cross College in Worcester, Massachusetts. Technical program of this Regional Technical Conference will present fundamentals of both theory and practice of injection molding. Developed with the cooperation of SPE's Injection Molding Professional Activity Group, this program comprises informal classroom lectures by leading technical experts followed by panel discussions geared to audience participation.

Sponsorship of educational Workshops by SPE Sections was inaugurated in 1959 when a program on "Plastics Extrusion" was presented in three widely separated U.S. locations. Educational programs of this type apply theoretical information on a particular phase of the plastics industry to specific design and processing problems. Considerable time is devoted to audience participation in discussions of operating problems and questions.

Requests for program and registration information should be directed to Roger Johnston, RETEC Chairman, c/o Foster Grant Inc., 289 North Main Street, Leominster, Massachusetts. The complete technical program follows.

PLASTICS INJECTION MOLDING WORKSHOP

April 4-5, 1961

Holy Cross College, Worcester, Mass.

April 4, 1961

Lectures

Moderator: Neil Keiser, E. I. du Pont de Nemours & Company

Speakers: "Fluid Flow and Heat Transfer Fundamentals in Injection Molding"
Richard L. Ballman, Monsanto Chemical Company

"Fundamentals of Heating Cylinder Design and Performance"
Albert Spaak, W. R. Grace & Company

"Application of Theory to Injection Molding Practice"
R. J. Pecha, Union Carbide Plastics Company

"Nozzle Design for Efficient Operation"
Gerald D. Gilmore, Bopp-Decker Plastics Company

Panel Discussions
(all speakers present)

Moderator: Roger B. Staub, Union Carbide Plastics Company

April 5, 1961

Lectures

Moderator: B. A. Olmstead, Package Machinery Company

Speakers: "Hydraulics and Mechanisms in Injection Molding"
P. D. Kohl, E. I. du Pont de Nemours & Company

"Plant Layout and Handling of Materials"
D. B. Semeyn, Dow Chemical Company

"Maintaining Molding Production"
John A. Kavanagh, Standard Tool Company

Panel Discussion
(all speakers present)

Moderator: Irvin I. Rubin, Robinson Plastics Corporation

(Continued from page 158)

time or both. The only caution here is with respect to warpage in that a critical value of cooling time for any one specific design must be determined to avoid distortions after removal from the mold. Reduction of pressure will also reduce dimensions but care must be exercised with this method to avoid poor finish and possible lack of density. A last method is increasing the mold temperature but caution is again directed in that the steel dimensions also change.

If the dimensions are found to be smaller than required the quickest and most satisfactory method of correction is an increase in the gate thickness or area, preferably using the thickness method. The only caution here is the avoidance of a gate greater than the greatest section thickness since an increase in the gate thickness beyond the maximum thickness of the part will be of no use in changing dimensions. Increasing dwell and cooling time, and increasing injection pressure will also decrease shrinkage but their effect is small compared to the result obtained with gate correction. It is suggested here that the size of gate chosen at the outset be reduced so that a deliberate excess shrinkage will be obtained, permitting a step-by-step adjustment to be made. If records of these adjustments are kept for future reference, the accumulation of experience will be valuable for future design.

The study of dimensions resulting from short shots offers the molder a valuable tool in determining the character of flow of the acetals and will help the designer of the product in determining where critical areas of control will be located. As a typical case, the design of small gears using acetal resins does not parallel that of other materials in that even very fine pitch gears can be molded with extreme precision if section thicknesses around the hub and web are carefully determined to avoid the choking off of flow. In gears finer than 32 D.P. and smaller than ½" pitch diameter it is possible to hold bore tolerances of less than .001" spread and pitch diameter tolerances of less than .002" spread.

The final point of importance is the factor of economy of control. It is in this area where most molders, and, in fact many misguided customers, go wrong. Control as discussed above can be very readily applied to a single cavity mold; but, when the number of cavities is greater than one, every single factor of control becomes compounded by the additional variables of cavity multiplicity. If more than one cavity must be used, then every technique recommended for balancing must be applied and thoroughly practiced. The mold maker should be placed on a tool tolerance schedule and not permitted to decide for himself just how much of the product tolerance he may consume. It is far simpler and certainly less costly for a toolmaker to grind a diameter within a few ten-thousandths or a thickness within the same limits than for a molder to correct the tool error to the same level. The heart of dimensional control falls squarely in the toolmakers' hands at the very beginning of the process and a few more dollars spent on the tool may save thousands later. To avoid the problem of variation from cavity to cavity the smallest number of cavities should be used. *It is preferable to make two molds of one cavity each where extreme control is required rather than to make a two-cavity mold.*

The cost of molding to close tolerances need not be high if the molder practices his art with engineering techniques rather than with artisans' skill. There is no short cut around design and analysis, and the molder who desires precision in his work must use that same precision in his study. Patience in recording data, thoroughness with detail, and consistency in method add up to a satisfactory result. The acetal resins offer the molder and his customer a facility where stability is high and quality can be achieved to an extreme limit.

Employment & Service Guide

POSITIONS OPEN

SALES REPRESENTATIVE

Experience in plastics essential, extrusion preferred for central and western Pennsylvania and West Virginia. Send full particulars, references to Box No. 162, SPE JOURNAL, Stamford, Conn.

RESEARCH CHEMIST

Wanted: Chemical Engineer or Chemist for development work with flexible packaging materials. Plastics experience desired, but not necessary. Write Mr. T. J. Wade, Crown Zellerbach Corporation, Western-Waxide Division, 2101 Williams Street, San Leandro, California.

EXTRUSION ENGINEER

For expanding Development section in progressive company. Must have adequate engineering background. Box No. 184, SPE JOURNAL, 65 Prospect St., Stamford, Conn.

PROJECT MANAGER THE POLYMER CORPORATION

A young progressive and rapidly growing company in the industrial plastics field, located in Reading, Pennsylvania has an excellent position available in its organization for a man with broad ability and training in the engineering field. We require 2-5 years experience in field sales work.

Major responsibilities, development of markets for new products, recommending effective marketing methods, customer contact, dissemination of technical data on new developments to field sales personnel. This position offers an excellent opportunity to one who is eager to accept challenge and responsibility.

Please address reply, furnishing education, experience and personal data to—
Personnel Department
THE POLYMER CORPORATION
P. O. Box 422
Reading, Pennsylvania
All replies kept strictly confidential.

MANUFACTURER'S REPRESENTATIVES

Wanted by growing and progressive custom molding plant. Open areas in Massachusetts, Northern New England and New York. Desire men with thorough knowledge of plastic molding and small electrical assemblies and capable of offering design suggestions to potential customers. Reply to P. O. Box 359, Wallingford, Conn.

PLASTICS ENGINEER

Experienced young engineer, 28 to 40, who seeks growth opportunity with publicly owned company. Exceptional potential for company and personal growth. Must know injection, compression and transfer molding of precision parts, from estimating of tools and parts to design and production. Very attractive compensation arrangement for the man who really fits our young and progressive group. Box No. 177, SPE JOURNAL, 65 Prospect St., Stamford, Conn.

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This work is concerned with applications research directed toward ultimate utilization as engineering materials for civilian and military communications applications.

It involves activities on the basic properties of polymers, plastics and adhesives, and will include the evaluation and thorough characterization of such materials as polyolefins, vinyls, ABS plastics, phenolics, casting resins, polycarbonates, polyesters, and epoxies for applications such as injection molding, extrusion, adhesives, laminates and coatings.

Examples of such activities would be work in aging, weathering, stabilization, and modification through compounding, formulation of new and existing polymers for specific applications, and treatment of surfaces for adhesion.

M.S. or Ph.D. degree in Organic or Physical Chemistry with polymer emphasis is desirable plus experience in plastics technology.

Send résumé to Director of Technical Employment, Department 815-J, Bell Telephone Laboratories, Murray Hill, New Jersey. Information will be held in confidence.

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RESEARCH ENGINEERS

PLASTICS PROCESS

The Research Division of American-Standard has openings for Chemical Engineers to carry out fundamental and long-range development research programs in the fields of Plastics and Process Engineering. Work includes theoretical and experimental studies oriented toward the development of new commercial and industrial products and processes. Projects are basic in nature, extremely diverse and offer a challenge to the creative researcher.

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PLASTIC DEVELOPMENT ENGINEER

Background 15 years Injection Molding, Model Development, scale, toys and patent, Vacuum Forming, Fabrication, Experimental Compression Molding, Shaped and Sheet Extrusion, Maintenance and Tools. Very complete knowledge of Expandable Styrene, Molds, automation, methods, etc.

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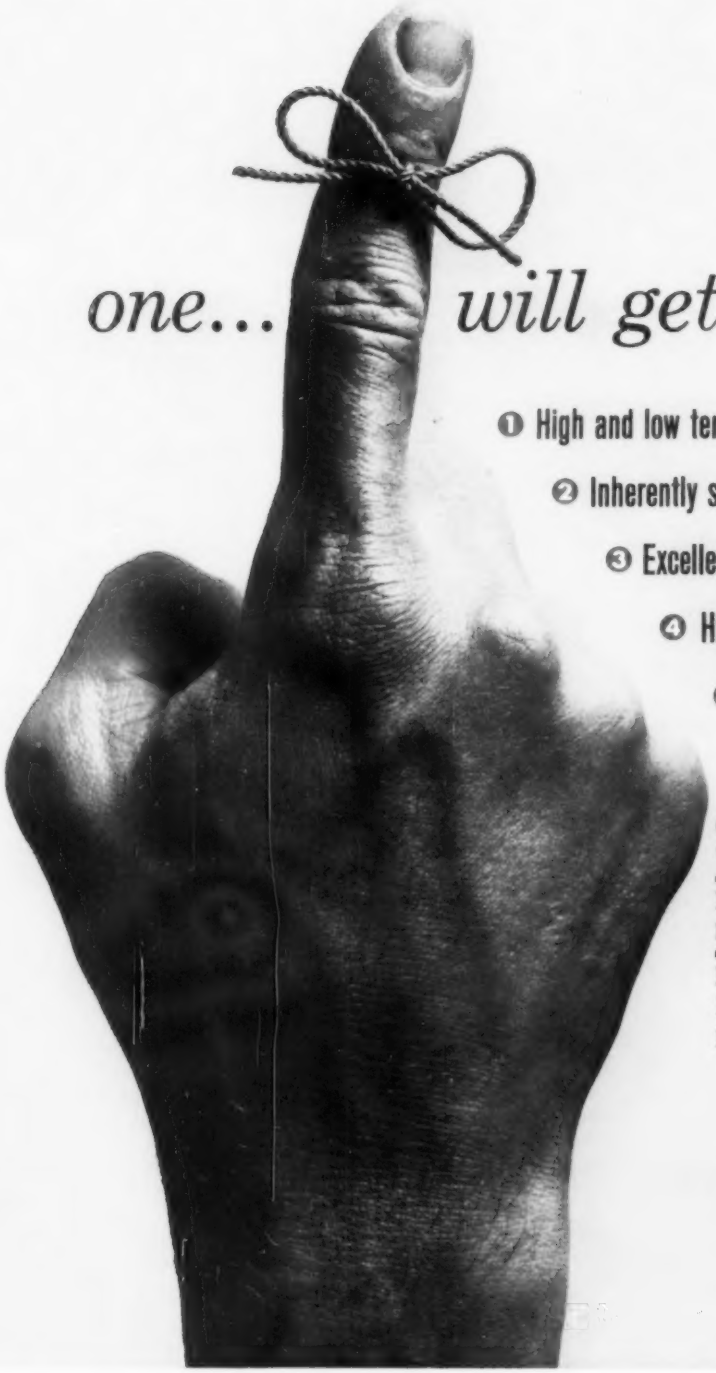

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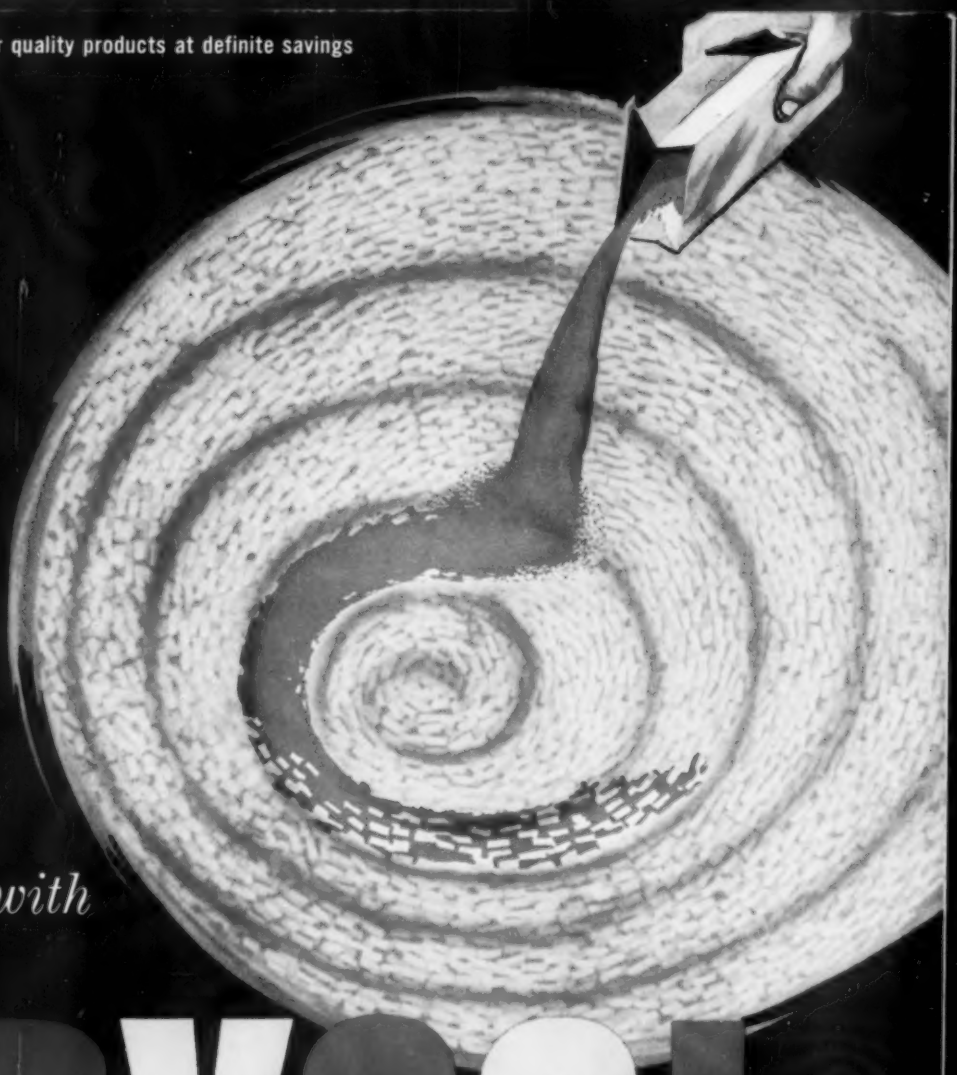

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